

**AN EVALUATION OF A MODEL OF TEACHER PROFESSIONAL  
DEVELOPMENT IN A SCIENCE AND MATHEMATICS INTERVENTION  
PROGRAMME FOR TEACHERS AND LEARNERS.**

**by**

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## DECLARATION

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## ABSTRACT

South Africa is in the midst of a mathematics and science education crisis that challenges all key role-players. The Institute for Mathematics and Science Teaching at the University of Stellenbosch (IMSTUS), was involved in several university-school partnership (systemic intervention) projects that sought to provide continuing professional development to mathematics and science teachers and to help them make a greater impact on the learners that they teach. One of these intervention projects was the Sciences and Mathematics Initiative for Learners and Educators (SMILES) that targeted mathematics and science teachers and learners in under-resourced schools in the Western Cape.

The effects of an intervention aimed at supporting and enhancing teacher professional development will only be seen in the learners once teachers have accepted and mastered the pedagogies proposed. Professional development that does not “*enthuse, support, train and renew, and encourage*” will probably fail. When considering this, the question that must be asked is whether the SMILES project was in fact enthusing, supporting, training, renewing and encouraging. The purposes and aims of the SMILES project with specific reference to professional development of science teachers were to enhance teachers’ pedagogical content knowledge and address the critical issues confronting science education of which three are: constructivist teaching, understanding the nature of science, and scientific argumentation. The characteristics of effective professional development, the core features of professional development and the theoretical constructs to evaluate professional development of teachers were used in this study to evaluate the effectiveness of the model used in the SMILES project.

A concurrent version of the mixed method approach was adopted for the collection and analysis of the data. Although causality is always difficult to prove in a school setting because of the many variables that affect student performance, improved student achievement is the ultimate litmus test for teacher professional development effectiveness. Analysis of the National Senior Certificate results of the project schools compared with the National and Provincial results indicated that the project schools on the whole fared better than the National results. The project schools outperformed the

national and provincial results for Life Sciences in 2011, 2012 and 2013 by at least four percentage points. The highest result achieved was 85,5% in 2011. In 2012 and 2013 these results were 82,7% and 83,0% respectively. In Physical Sciences the project schools started with results below that achieved nationally (34,7%) and then ended up with a pass percentage within half a percentage point of the provincial result (72,1%). The Mathematics results were not as positive. The project schools started by achieving a 63,4% pass rate and ended with a percentage pass rate of 63,3% having initially taking a dip down to 51,3%. At the end of the intervention the Mathematics results were better than the national results but were 10% lower than the Provincial average.

Although it is difficult to pin down the results solely to the effects of the intervention, the comparison with provincial and national results reasonably controls for most of the extraneous variables including variations in enrolments in these subjects. On the affective side it is almost certain that the attitude of the learners and the teachers toward their respective subjects improved during the tenure of the project. This could have had a positive effect on the National Senior Certificate results achieved by the project schools.

## OPSOMMING

Suid-Afrika is midde in 'n wiskunde en wetenskap onderwyskrisis wat alle sleutelrolspelers uitdaag. Die Instituut vir Wiskunde en Wetenskaponderwys aan die Universiteit van Stellenbosch (IWWOUS), was betrokke by verskeie universiteit-skool vennootskapsprojekte (sistemiese intervensie) wat gepoog het om voortgesette professionele ontwikkeling te bied aan wiskunde en wetenskap onderwysers en hulle te help om 'n groter impak op die leerders wat hulle onderrig, te maak. Een van hierdie intervensie-projekte was die Wetenskappe en Wiskunde-inisiatief vir leerders en opvoeders (SMILES) wat wiskunde en wetenskap onderwysers en leerders, in hulpbronarm skole in die Wes-Kaap, geteiken het.

Die impak van 'n intervensie wat daarop gemik is om onderwyser professionele ontwikkeling te ondersteun en bevorder, sal eers in die leerders waargeneem kan word, wanneer onderwysers die voorgestelde pedagogieë aanvaar en bemeester. Professionele ontwikkeling wat nie "begeester, ondersteun, oplei en vernuwe asook aanmoedig" nie, sal waarskynlik misluk. Hierdie stelling in ag genome, is die vraag wat gevra moet word, of die SMILES-projek werklik onderwysers begeester, ondersteun, opgelei, vernuwe en aangemoedig het. Die doelstellings en doelwitte van die SMILES projek, met spesifieke verwysing na die professionele ontwikkeling van Wetenskap-onderwysers, was om onderwysers se pedagogiese inhoudelike kennis te versterk en om kritieke kwessies waarmee wetenskap-onderwys gekonfronteer word, aan te spreek. Drie van hierdie kwessies is, konstruktivistiese onderrig, begrip van die aard van wetenskap en wetenskaplike argumentering. Die eienskappe van effektiewe professionele ontwikkeling, die kern kenmerke van die professionele ontwikkeling en die teoretiese konstrakte om professionele ontwikkeling van onderwysers te evalueer, is in hierdie studie gebruik om die doeltreffendheid van die model wat in die SMILES-projek gevolg is, te evalueer.

'n Gelyklopend gemengde-metode benadering is gevolg vir die insameling en ontleding van die data. Hoewel oorsaaklikheid altyd moeilik is om in 'n skoolopset te bewys, as gevolg van die baie veranderlikes wat studente se prestasie beïnvloed, is verbeterde studente prestasie die uiteindelijke lakmoestoets vir doeltreffendheid van professionele

onderwyser-ontwikkeling. Ontleding van die Nasionale Senior Sertifikaat-uitslae van die projek-skole, in vergelyking met die nasionale en provinsiale resultate, dui daarop dat die projek-skole oor die algemeen beter gevaar het as die nasionale uitslae. Die projek-skole het die nasionale en provinsiale skole se resultate vir Lewenswetenskappe in 2011, 2012 en 2013 met ten minste vier persentasie punte oortref. Die hoogste resultaat behaal was 85,5% in 2011. In 2012 en 2013 was hierdie uitslae onderskeidelik 82,7% en 83,0%. In Fisiese Wetenskappe het die projek-skole met resultate onder wat nasionaal behaal was (34,7%) begin, en geëindig met 'n uiteindelijke slaagpersentasie binne 'n halwe persentasiepunt van die provinsiale resultate (72,1%). Die wiskunde-uitslae was nie so positief nie. Die projek-skole het begin met 'n 63,4% slaagsyfer en geëindig met 'n slaagpersentasie van 63,3% na 'n aanvanklike insinking na 51,3%. Aan die einde van die intervensie was hul Wiskunde-resultate beter as die nasionale resultate, maar 10% laer as die provinsiale gemiddelde.

Alhoewel dit moeilik is om die resultate slegs vas te pen aan die gevolg van die intervensie, dien die vergelyking met provinsiale en nasionale resultate as redelike kontroles vir meeste van die eksterne veranderlikes insluitend variasies in inskrywings in hierdie vakke. Op die affektiewe vlak is dit byna seker dat die gesindheid van die leerders en die onderwysers ten opsigte van hul onderskeie vakke verbeter het tydens die projek. Dit kon moontlik 'n positiewe uitwerking op die projek-skole se Nasionale Senior Sertifikaat resultate gehad het.

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## ACRONYMS

CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
FET	Further Education and Training Band (Grade 10-12)
IMSTUS	Institute of Mathematics and Science Teaching at the University of Stellenbosch
MMR	Mixed methods research
NDP	National Development Plan
NOS	Nature of Science
NSC	National Senior Certificate
PCK	Pedagogical Content Knowledge
PLC	Professional learning community
SACE	South African Council for Educators
SACMEQ	Southern African Consortium for Measurement of Education Quality
SMILES	Sciences and Mathematics Initiative for Learners and Educators
STEM	Science, Technology , Engineering and Mathematics
SUNCEP	Stellenbosch University Centre for Pedagogy
TAP	Toulmin's argument pattern
TIMSS	Third International Mathematics and Science Study (prior to 2003)
TIMSS	Trends in International Mathematics and Science Study (after 2003)
WCED	Western Cape Education Department

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## CHAPTER 1

### INTRODUCTION AND ORIENTATION TO THE STUDY

#### 1.1 INTRODUCTION

In this chapter the rationale for this study is introduced by sketching the background and context in which this study is framed. The problem that this study wishes to address is stated and the main research question is spelled out and the research sub-questions are highlighted. The significance of the study is outlined and the limitations and delimitations thereof discussed. The key terms of the study are then identified and defined before the outline of the thesis is finally given detailing what can be expected in each chapter.

#### 1.2 BACKGROUND TO THE STUDY

South Africa is in the midst of a mathematics and science education crisis that challenges all key role-players with the capacity to make a change to come to the party and make a contribution. The crisis has been confirmed through several international benchmark studies for example TIMSS-1995 (Third International Mathematics and Science Study), TIMSS-R 1999, TIMSS 2003 (Trends in International Mathematics and Science Study) and TIMSS 2011. Martin, et al. (2000); Martin, Mullis, & Chrostowski (2004); Reddy (2006); Mullis, et al. (2000); Reddy (2012) report the following results found in table 1.1 obtained in Mathematics and Science for the South African schools in the TIMSS assessments.

In table 1.1 it can be seen that South African schools were ranked the lowest in the TIMSS assessments for mathematics and science every year except for the mathematics assessment in 2011 when they came second last. In 2011 South Africa and two other countries tested grade 9 learners using the grade 8 test which was written by the other 42 countries. (Ndlovu & Mji, 2012)

Test	Position	Grade tested worldwide	Grade that wrote in RSA
TIMSS 1999 Science	38 <sup>th</sup> out of 38	8	8
TIMSS 1999 Mathematics	38 <sup>th</sup> out of 38	8	8
TIMSS 2003 Mathematics	50 <sup>th</sup> out of 50	8	8
TIMSS 2003 Science	50 <sup>th</sup> out of 50	8	8
TIMSS 2011 Mathematics	44 <sup>th</sup> out of 45	8	9
TIMSS 2011 Science	45 <sup>th</sup> out of 45	8	9

Table 1.1 The relative position of South Africa when compared with the rest of the TIMSS participating countries in mathematics and science.

In the 2012 report of The National Senior Certificate examinations (Department of Basic Education, 2012, p5) it is reported that there is a marked increase in the results achieved in Physical Sciences and Mathematics. The pass rate for Physical Sciences increased from 36.8% in 2009 to 61.3% in 2012. This is indeed a big increase but unfortunately the report of 2012 also shows that the number of learners offering the subject has declined by over 40000. In Mathematics the pass rate is reported to have increased from 46% to 54% over the 4 years but the number of learners writing Mathematics has declined by almost 70000. The increased pass rate due to less and less learners taking these gateway subjects indicates a problem in the system that has to be addressed urgently.

The picture becomes bleaker if one considers that the pass rates quoted above are valid for those who achieved more than 30 % in the final examination. The minimum requirement in Mathematics and Physical Sciences at most tertiary institutions for related degrees is above 50%. This requirement effectively closes the gate for those learners who do not reach this bench mark.

The Global Competitiveness Report of the World Economic Forum (Schwab, 2012,p41) states the following about South Africa:

“Efforts must also be made to increase the university enrollment rate in order to better develop its innovation potential.”

And then in general the following is said:

“Basic education increases the efficiency of each individual worker. Moreover, workers who have received little formal education can carry out only simple manual tasks and find it much more difficult to adapt to more advanced production processes and techniques, and therefore contribute less to come up with or execute innovations. In other words, lack of basic education can become a constraint on business development, with firms finding it difficult to move up the value chain by producing more sophisticated or value-intensive products with existing human resources.” (p5)

The emphasis placed on basic education by the World Economic Forum is clear because it has a direct link to the economy. South Africa’s unemployment rate and the widespread poverty could therefore be a symptom of the education crisis. The TIMSS 2011 (Reddy, 2012, p4) results of Korea were the best in science which correlates with their health and primary education score of 15<sup>th</sup> out of 144 countries reported on in the Global Competitiveness Report for 2011-2012 (Schwalb, 2011,p18).

The most problematic factor for doing business in South Africa, as listed by the World Economic Forum in its global competitiveness report is an “inadequately educated workforce”. South Africa’s quality of mathematics and science education is rated 2<sup>nd</sup> worst in the world (Schwab, 2012, p443).

In the National Development Plan (NDP) (National Planning Commission, 2011) it is made clear that Science and Technology are important for economic development.

“Science and technology are key to development, because technological and scientific revolutions underpin economic advances, improvements in health systems, education and infrastructure.” (p. 70)

The emphasis on education and the role that it plays in our economy is highlighted in the NDP. One of the targets for schools to achieve by 2030 is that 80% of schools and learners must achieve 50% or more in literacy, mathematics and science in grades 3, 6 and 9 (National Planning Commission, 2011, p. 275). Another target highlights mathematics and science as gateway subjects by saying that the number of students eligible to study mathematics and science at university must increase to 450 000 per year (National Planning Commission, 2011, p. 276). This would more than triple the results achieved in 2010.

As a consequence of this crisis, South Africa has a severe shortage of learners matriculating with mathematics and science marks that qualify them for further study in Science, Technology, Engineering and Mathematics (STEM) (Fricke, Horak, Meyer, & Van Lingen, 2008). The shortage of learners qualifying to follow degrees in the sciences points to a lack of suitably qualified teachers (Fricke, Horak, Meyer, & Van Lingen, 2008) (Maree, 2006).

The Institute for Mathematics and Science Teaching at the University of Stellenbosch (IMSTUS), like many other similar institutional efforts, was involved in several university-school partnership (systemic intervention) projects that sought to provide continuing professional development to mathematics and science teachers and to help them make greater impact on the learners that they teach. One of these intervention projects was the Sciences and Mathematics Initiative for Learners and EducatorS (SMILES) that targeted mathematics and science teachers and learners in under-resourced schools in the Cape Winelands District of the Western Cape. The author conducted research to inform as to whether an intervention of this nature made a positive contribution to teachers and learners or not. This study took into account the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa (Departments of Basic Education & Higher Education and Training, 2011). The Integrated Strategic Planning Framework for Teacher Education and Development in South Africa emphasises the importance of building professional learning communities (PLC). In these PLCs teachers recognise their own experience and expertise and come to a point where they share this experience with other teachers. This process has many assumed benefits, one being that teachers feel valued by their

colleagues and the education system in general, but is still largely unexplored in the context of disadvantaged and marginalised schools.

### **1.3 STATEMENT OF THE PROBLEM**

The question that must constantly be answered by those engaged in the continuing professional development of teachers through in-service training is: Is this model or form of professional development achieving the desired change in the professional practices of the participating science teachers and are the clients (the learners) ultimately benefitting in terms of learning enhancement?

This question is not easily answered as there is a multitude of factors that influence teachers as well as the facilitators who try to bring about change. Those seeking quantitative validation of their efforts are often disillusioned as the ultimate measure of success lies in the assessment results obtained by the learners after being subjected to the improved practices of the teachers. It stands to reason that the effects of an intervention aimed at supporting and enhancing teacher professional development will only be seen in the learners once teachers have accepted and mastered the pedagogies proposed.

The process of acceptance and mastery takes a great deal of time and there are many factors that could jeopardise it. As such the effects of the interventions are only seen in learners results sometimes long after the intervention has ended. The model of an intervention therefore could be more effective if it could change according to the needs of the teachers at the different stages of the project. For instance if the project could focus on the acceptance phase as long as is needed before moving on to mastery of the pedagogy by the teachers it would be more effective than simply pushing ahead because of time constraints.

The funder of the SMILES project gave the service provider freedom to adapt the model of the project in order to better address the unique needs of the different teachers in the different schools. For this reason the model constantly evolved and could be nuanced for each school, teacher and phase in the project. Generic solutions were the exception as each mathematics teacher or science teacher and school had different needs. The one common thread to the project was that the facilitators had to

be supportive and helpful on site in order to effect change rather than being critical and aloof.

In the IQMS (Integrated Quality Management System) (Department of Basic Education, 2004) documents that teachers use to appraise each other, the professional development needs of the educator are mentioned, if not addressed. It is clear that the professional development of educators is not just needed, it is critical for quality education. This is borne out by the following written by Graeme Bloch in his book, “The Toxic Mix What’s wrong with South Africa’s schools and how to fix it”.

Improving the quality of teachers, helping teachers teach *well*, is the most urgent task. More than anything else what happens at the coalface of interaction between teacher and pupil is the key. This means a whole new package of attempts to *enthuse, support, train and renew, and to encourage a new teaching corps*, as well as to establish non-negotiables on agreed and acceptable behaviours. (My Italics, (Bloch, 2009, p169)

Professional development that does not “*enthuse, support, train and renew, and encourage*” is a waste of time. When considering this, the question that must be asked is whether the SMILES project was in fact enthusing, supporting, training and renewing or was it something that was done to teachers in a top down fashion where teachers felt undermined and belittled? This leads us to the research questions that guided this study.

#### **1.4. RESEARCH QUESTIONS**

This study sought to investigate whether the SMILES intervention made a positive contribution to the teachers and learners involved in the project.

The following research question and sub-questions were therefore primary to this study:

What was the impact of the SMILES intervention model on teaching effectiveness?

- a) What were the perceptions of the teachers regarding the impact of the intervention?

- b) What were the perceptions of the School Management Teams (SMTs) regarding the impact of the intervention?
- c) What were the perceptions of the learners regarding the impact of the intervention?
- d) What was the impact of the intervention on learning outcomes, if any?
- e) What other factors were significantly at play during the intervention?

A distinction is made in this study between “teacher effectiveness” and “teaching effectiveness”. Teacher effectiveness refers to the effectiveness of the teacher themselves and not necessarily the outcomes of their teaching. A study on teacher effectiveness would be a particularly useful unit of analysis when researching pre-service offerings. In this study teaching effectiveness refers to the outcomes of teaching as well as the process of reaching those outcomes which would include “teacher effectiveness”. Studying teaching effectiveness therefore necessitates the analysis of learners performances based on the teaching in question.

## **1.5 SIGNIFICANCE OF THE STUDY**

Continuing teacher professional development lies at the heart of nearly every educational effort to improve student achievement (Supovitz and Turner, 2000). Yet nearly every major work on the topic of staff development has produced inconclusive results regarding effectiveness. On the one hand, Guskey (1986) attributes this inconclusiveness to a poor understanding of teachers’ motivations and a lack of insight into both the individual and environmental factors in the change seeking process. Understanding the motivations, environmental and personal factors of the teachers involved in the SMILES project was key. On the other hand (Little (1993) concludes that existing models of continuing professional development are inadequate to achieve ambitious learning goals. This suggests that professional development models should set realistic goals for themselves and take into account all the local factors. SMILES project schools were selected taking the context, amongst other factors which will be unpacked in chapter 3, into account.

Notwithstanding the failure of traditional models of professional development to realize their potential, continuing professional development is still widely seen as the best bet for changing teaching practices, because alternative methods, such as policies and

programmes that regulate teacher behaviour , have fared no better (Smylie, 1996). Traditional models could be lectures or workshops given out of the context of the teacher and not embedded in their realm. The evolving nature of the design of the SMILES project meant it could meet the changing demands of the teachers. The study would help map the nature of the changes in needs as the project unfolded. The SMILES project had to work within policies and programmes dictated by the Western Cape Education Department (WCED) and could not form their own policy and programme as if on an island. The policies and programmes of the provincial and national education departments affected not only the SMILES project but also each individual school and subject team. For the project to offer professional development to the different teachers in the different schools these policies had to be taken into account and adhered to, or else the acceptance by the different role players would have been minimal. The flexibility of the programme meant that the different aspects of the programme could be tailor made according to each need as and when it arose. Policy constraints, however, would always be there hence the study would shed light on the nature of the policy constraints and the nature of the adaptations that the constraints induced.

The tragedy is that the poor performance in mathematics and science was, and still is, a national crisis. To address this problem this study recognises Karpati's (2009) observation that no system of education can exceed the quality of its own teachers. Accordingly one fundamental way in which to address the challenge was to design and implement an intervention programme that could be responsive to the professional development needs of the educators as repeatedly identified by them. The study would shed light on the feasibility and sustainability of such a design feature of the model to better inform both theory and practice of school-based professional teacher learning. For Supovitz and Turner (2000) it is not just the quantity of the intervention that matters the most but also the quality of professional development in which teachers participate that is strongly linked to positive change in teaching practice and classroom culture. Desimone's (2009) core features of effective professional development will be discussed in chapter 2 which will describe the nature of quality professional development.

## **1.6 DELIMITATIONS OF THE STUDY**

The teachers who were asked to participate in this study were teaching either Mathematics, Natural Sciences, Life Sciences or Physical Sciences in the SMILES Secondary schools.

Mathematics included all mathematics content taught at high school. After learners have completed grade 9 they have the choice of either doing Mathematics Literacy or Mathematics. This project excluded Mathematical Literacy as it is not a subject that aids access to the Sciences at tertiary level. The project focussed rather on teachers and learners who opted for pure mathematics which is a key subject for access to university studies.

Natural Sciences refers to the general science that is taught to learners in Grades 8 and 9 in secondary schools. It includes four strands namely Life and Living, Matter and Material, Energy and Change and finally Earth and Beyond. These four strands prepare learners for the next phase in which they can choose to do Physical Sciences or Life Sciences. Life and Living links directly with Life Sciences and the other three strands link with Physical Sciences. Physical Sciences can then be broadly divided into two categories namely Physics and Chemistry.

The SMILES schools were selected after consultation with the WCED and the schools themselves. Ten schools were considered and five were chosen after initial information sessions were conducted with the teachers and the management teams of the schools. The five schools were situated in the Paarl, Kraaifontein and Stellenbosch regions in the Western Cape. Their close proximity made school visits and teaching sessions accessible to both facilitators and teachers.

All the teaching sessions and school visits by facilitators were made available to all the teachers in the SMILES schools. Input and feedback from these teachers, amongst others was used to produce the data for this study.

## **1.7 METHODOLOGY OF THE STUDY**

This study makes use of a mixed methods approach and therefore takes on both a qualitative and a quantitative collation and analysis of data. According to Mathison

(1998) good research practice obligates the researcher to triangulate, that is, to use multiple methods and data sources to enhance validity of research findings. The interpretive paradigm frames this study in that the author seeks to understand the effect that the project is having on the teachers and their perceptions thereof.

In order to get a fuller picture of the project, semi-structured interviews with teachers, school management and learners was undertaken. These were transcribed and the trends found in these interviews are highlighted. Further to this a survey using a Likert type questionnaire was administered which seeks to ascertain the perceptions of teachers regarding the SMILES project. A similar survey was given to the school management and the learners of those teachers to triangulate and to verify the results. In any areas where there were ambiguous statements, face validity or member checking was conducted where the researcher verified what the teacher or learner meant in the interview.

Observations made by facilitators in the project were also used to further verify trends or results that emerged.

## **1.8 LIMITATIONS OF THE STUDY**

Establishing a causal link between the inputs of the SMILES project and the achievements made by learners is not easy as there are many factors that influence the ultimate achievement of learners. With this in mind it is felt that merely looking at the results that learners achieve in high stakes summative testing may be a flawed measurement of the success or failure of a specific intervention. Controlling for factors that influence schools on a national and provincial scale will be included by comparing provincial and national results with the project schools.

## **1.9 DEFINITION OF KEY TERMS**

### **Facilitator**

This term in this study refers to the people who were employed to develop material, present and facilitate professional learning opportunities and to mentor and support teachers through classroom visits.

### **Teacher**

This term refers to the educators in their respective schools who were on the programme because their schools bought into the project. These teachers either taught Mathematics or the Sciences.

### **Learner**

This term most commonly used in South Africa, refers to the students of the teachers.

### **Teacher/learner sessions**

Teacher/learner sessions are extra lessons offered out of the normal school hours presented by the facilitators and attended by learners and teachers.

### **Workshops**

Workshops refer to professional learning opportunities that were given to teachers out of the school context.

### **Co-teaching**

Co-teaching refers to facilitators teaching in collaboration with the teacher. This is not merely observing and evaluating the teacher, it is taking an active role in facilitating the lesson to help ensure that learning takes place.

### **Shoestring science**

Shoestring science can be defined as teaching science using apparatus that can be made on a very tight budget. Recyclable material is often modified and used in a variety of different ways when teaching science on a shoestring budget.

### **Teacher Professional Development**

Professional development consists of all natural learning experiences and those conscious and planned activities which are intended to be of direct or indirect benefit to the individual, group or school and which contribute, through these, to the quality of education in the classroom.(Day, 1999). Although teacher professional learning has

come to have a different meaning these two terms will be used interchangeably in this thesis.

## **Intervention**

An intervention in this study refers to an act or series of actions that are put into place to effect positive growth.

## **Teacher Effectiveness**

Teacher effectiveness, in this study, refers specifically to the teacher and not necessarily the outcomes of the learning process. It includes all the factors that make teachers effective but focuses on the teacher and not necessarily their learners or their learner's perceptions or their learner's results.

## **Teaching Effectiveness**

Teaching effectiveness includes everything associated with teacher effectiveness but takes it a step further to include the learning outcomes associated with the teaching. For this reason the results of learners associated with the teacher and their response to the teaching is also considered.

## **1.10 THESIS OUTLINE**

Chapter two consists of a literature study detailing drawing on prior research in professional development and evaluative studies. The methodology used in conducting this research will be explained in chapter three as well as the reasons for choosing this methodology. The results from the data collected will be presented and analysed here in chapter four. Discussion of the results and presentations of conclusions that can be drawn from the resulted will form the final chapter.

## **1.11 CONCLUSION**

The SMILES project and more specifically the need for a project of this nature is clear when one looks at the state of mathematics and science education in South Africa. The

principal aims of the Constitution, Act No. 108 of 1996 include healing the divisions of the past, establishing a society based on democratic values, social justice and fundamental human rights, improving the quality of life of all citizens and freeing the potential of each person. This means that the constitution entitles every learner to quality education in order to fully realize the individual's potential. The constitution also makes provision for the state to redress the imbalances and inequities of the past. Education as a basic human right includes quality mathematics and science education for all. Equal opportunities irrespective of race or class should be made available to all.

The various international assessment tools show that South Africa has an education system that is at the bottom end of the global scale. The economic link with education is strong and unfortunately is proven true in South Africa where our unemployment and poverty indices are horrendous.

In the next chapter the existing literature will be reviewed pertaining to professional development of teachers and the evaluation of projects that seek to develop teachers professionally.

## CHAPTER 2

### LITERATURE STUDY

#### 2.1 INTRODUCTION

This chapter will review the current research pertaining to effective science teacher professional development models and articulating the theoretical framework that underpinned the SMILES project together with the research that supports it. This research informed the SMILES facilitators and the project management team of current trends as well as best practice gleaned from other similar projects.

The literature review culminates in a logic framework for the SMILES project as a local adaptation to address the perceived professional development needs of the teachers in the project.

The purposes and aims of the SMILES project with specific reference to science in-service teacher education were to address the critical issues confronting science education of which three are: constructivist teaching, understanding the nature of science, and scientific argumentation.

Schuster and Carlsen (2009) argue that scientific research as practiced in industry is far removed from the way science is taught by teachers. The narrowing of this gap can be brought about through teacher professional learning where teachers are exposed to the research and methods used by practicing scientists. One of the characteristics of the nature of science (NOS) is that scientific knowledge is tentative. This in itself lends itself to constructivist or inquiry based approaches to science teaching. A shift such as this in teaching practice will require teachers to be in full control of their subject matter knowledge (SMK) and their pedagogical content knowledge (PCK). If this is not the case and they are not adequately knowledgeable then they will probably avoid constructivist or open enquiry approaches which could expose their lack of knowledge. We should be ready to try new ideas in an effort to provide a new mode of teaching for a different world from the one in which we were taught. Albert Einstein's statement comes to mind: "A new type of thinking is essential if mankind is to survive and move toward higher levels."

He was not talking about education per se but it does apply to education and the development of professional teachers nonetheless.

## **2.2 CRITICAL ISSUES CONFRONTING SCIENCE EDUCATION**

### **2.2.1 The creation of constructivist learning environments in reformed science classrooms**

Windschitl (2002) lists the following as the key features of a constructivist classroom:

- Teachers elicit students' ideas and experiences in relation to key topics, and then fashion learning situations that help students elaborate on or restructure their current knowledge.
- Students are given frequent opportunities to engage in complex, meaningful, problem-based activities.
- Teachers provide students with a variety of information resources as well as the tools (technological and conceptual) necessary to mediate learning.
- Students work collaboratively and are given support to engage in task-oriented dialogue with one another.
- Teachers make their own thinking processes explicit to learners and encourage students to do the same through dialogue, writing, drawings, or other representations.
- Students are routinely asked to apply knowledge in diverse and authentic contexts, to explain ideas, interpret texts, predict phenomena, and construct arguments based on evidence, rather than to focus exclusively on the acquisition of predetermined "right answers."
- Teachers encourage students' reflective and autonomous thinking in conjunction with the conditions listed above.
- Teachers employ a variety of assessment strategies to understand how students' ideas are evolving and to give feedback on the processes as well as the products of their thinking. (p137)

It is clear from the above that learning is centred on the student and that the role of the teacher is to make resources, situations and conditions available in order that learners

can begin to think autonomously and reflectively. Learners are given opportunities to engage with meaningful actual problems and are supported in developing problem solving strategies. The process of gaining the knowledge is as important as the product of that knowledge and as such different ways of assessment have to be employed to reflect the process knowledge gained by learners. In the SMILES project, the teacher professional learning opportunities were based on these constructivist principles and facilitators would model this approach during these opportunities.

Transmission models of instruction where the teacher is the authority and everything that is done in the classroom is geared towards transferring knowledge from the teacher or textbook to the learner in the hope that the learners can deliver that knowledge back during assessments seems to be the default teaching model in Western schooling according to Windschitl (2002). This model of teaching was also prevalent in the SMILES project schools and facilitators constantly tried to model the constructivist approach to teaching as the preferred model. In the transmission model learners' prior knowledge or ideas are not considered but in the constructivist teaching model this is the starting point. Their ideas and input are valuable because they give the necessary platform on which the teacher needs to build the lessons.

### **2.2.2 Understanding the nature of science in reformed science teaching**

In the physical sciences CAPS (Department of Basic Education, 2011b) under the paragraph titled "Specific Aims of Physical Sciences" the following paragraph is found:

"Physical Sciences promotes knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships to technology, society and the environment." (p. 8)

From this it is clear that the Department of Basic Education (DBE) values the promotion of an understanding of the nature of science (NOS). It was therefore important for the facilitators in the SMILES project to make teachers aware of NOS and the implications that this awareness would have for the teaching of physical sciences. Linneman, Lynch, Kurup, Webb, & Bantwini (2003) contend that generally studies show that there is a vague or shallow understanding of the NOS by teachers and they have regarded it as increasingly less important for mathematics and the sciences. Linneman et al (2003) go on to say that "...the NOS remains a difficult and problematic

construct to deal with and presents many challenges for the teacher and teacher educator.” Considering Abd-El-Khalick, Bell, & Lederman’s (1998) description of the Nature of Science it is understandable that the NOS is a complex construct and that there are many factors to consider when applying it to the classroom situation. The characteristics of NOS that they list are as follows: 1) scientific knowledge is tentative (subject to change); 2) empirically based (based on and/or derived from observations of the natural world); 3) subjective (value-laden); 4) partly the product of human inference, imagination, and creativity (involves the invention of explanation); and 5) socially and culturally embedded. It is these characteristics of science that teachers in the SMILES project were exposed to by the facilitators during workshops and other learning opportunities.

Teachers in the SMILES project were constantly shown that physical sciences is not just something that happens in the classroom but that it is indeed a part of everything that takes place in the natural world. They were also given opportunities to share their own ideas and theories particularly when dealing with indigenous knowledge. Investigations to prove empirically that theories were true were carried out. In the Natural Sciences CAPS (Department of Basic Education, 2011a, p. 8) it is stated that the science knowledge that is taught in schools is not in doubt however when the knowledge was first investigated there would have been doubts and it would have changed once new evidence was exposed. Abd-El-Khalick et al (1998) make the point that scientific knowledge is subject to change and here we see in the CAPS document that teachers should make learners aware of this even though the knowledge contained in the curriculum has been accepted as true for years. The NOS was modelled to the teachers, however it was not explicitly taught.

### **2.2.3 Understanding the role of argumentation in the construction of scientific knowledge in the classroom**

Scientific argumentation is the process of constructing a logical piece of writing where relevant information is used to come to valid conclusions. This argumentation is not debate, but rather refers to drawing conclusions from observations in a logical manner.

In the Natural Sciences CAPS (DBE, 2011a, p. 10) the following is stated under process skills: “The teaching and learning of Natural Sciences involves the

development of a range of process skills that may be used in everyday life, in the community and in the workplace. Learners also develop the ability to think objectively and use a variety of forms of reasoning while they use these skills” Argumentation has to be one of the forms of reasoning alluded to here.

Newton, Driver, and Osborne (1999) list the reasons for explicitly teaching argumentation in science classes. These are:

Firstly, scientific knowledge is developed through the process of argument. Scientists perform investigations, observe the results and then present their findings to others. In this presentation the argumentation process begins. The peers then will probe, debate, criticize and review the presentation which is how science knowledge is generated. Secondly, through argumentation learners will build up their scientific knowledge and scientific vocabulary through the texts they write and presentations they make in support of their findings. Finally, learning argumentation skills are not just applicable in the sciences but can be used and applied in any free and democratic society. Presentation of an argument in a clear and coherent way is a skill that can be applied universally.

Toulman’s argument pattern (TAP) gives a starting point for teachers and teacher educators for applying argumentation in the classroom (Erduran, Simon, & Osborne, 2004). Figure 4.1 shows the starting point to be data followed by the process.

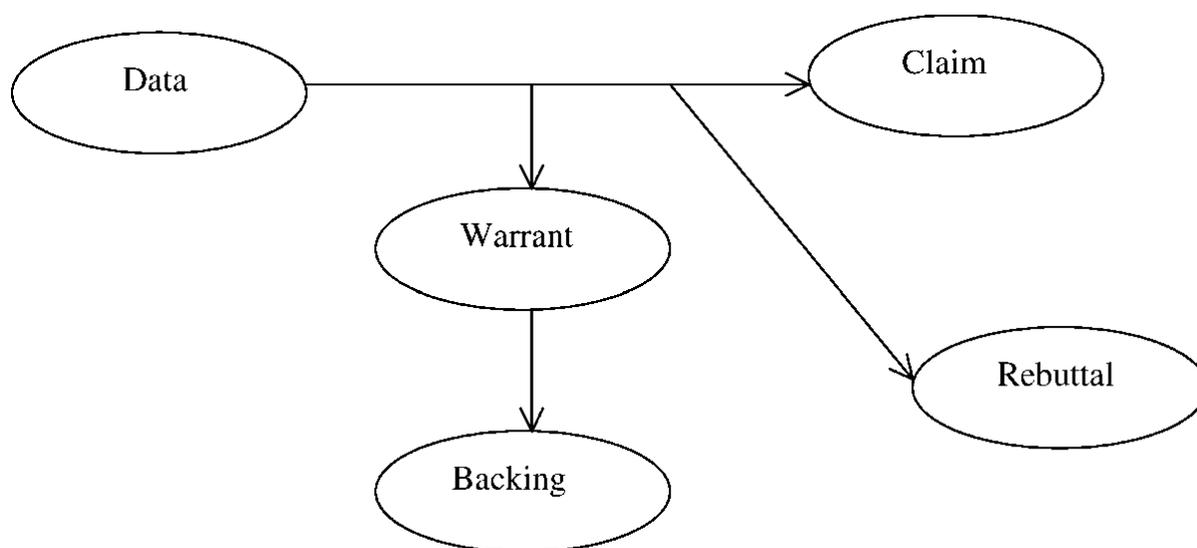


Figure 2.1: Toulmin’s argument pattern  
(Adapted from Erduran, Simon, & Osborne, 2004, p. 918)

Claims refer to assertions regarding what exists or what people believe to be true. Data is any evidence which can be used to support the claim. Warrants make the relationship between the claim and data clear. Underlying assumptions that are not explicit are referred to as backings in TAP. Rebuttals are responses to the data, warrants, or backing that contradict or refute them. The rebuttal will of course begin the argument again with either new data or the existing data. The rebuttal then will have all the components of TAP. This framework can be particularly useful for teachers to categorise the elements of the argumentation process in the classroom to highlight to learners what each are saying and how it fits in with the process of knowledge production. When teachers are aware of TAP it could lead to a healthier non-confrontational response to argumentation as the process is seen as growth in understanding and knowledge. In the SMILES project this was not explicitly taught but the process was modelled during the professional learning opportunities. Teachers' conceptions relating to the content and how the content could be presented were entertained. Whenever misconceptions arose this would be an opportunity to use argumentation as a strategy to create a new conception.

#### **2.2.4 Schematic summary of critical issues in science education**

The three critical issues in science education are interlinked and where they all intersect is when the richest learning is taking place using the nature of science as a platform for constructivism and argumentation.

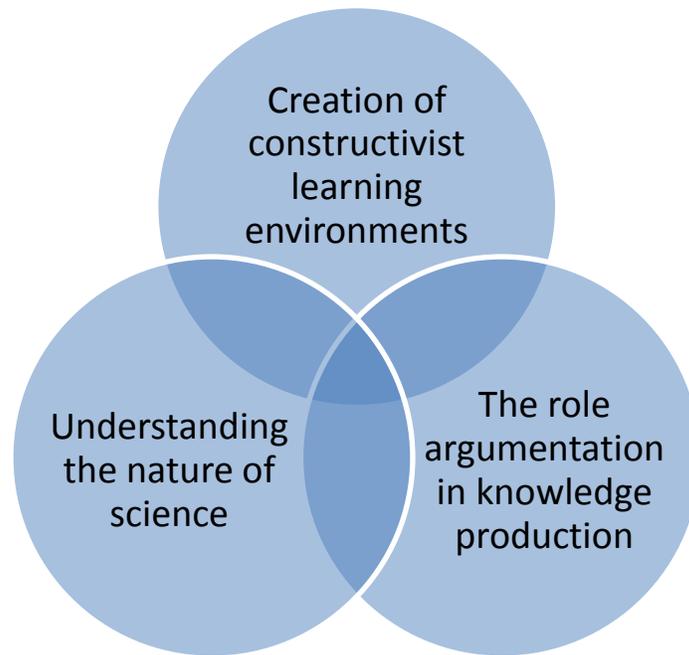


Figure 2.2 The critical issues in science education.

## 2.3 FUNDAMENTALS OF SCIENCE TEACHER PROFESSIONAL DEVELOPMENT

The following are fundamental concepts of teacher professional development discourse in general which also apply to mathematics and science teachers.

### 2.3.1 Pedagogical Content Knowledge

Shulman (1986) states clearly that the difference between those who practice a skill and those who practice a profession is that the professional knows not only how, but what and why as well. He adds that the professional teacher is “capable of reflection leading to self-knowledge” and “capable of communicating the reasons for professional decisions and actions to others” (Shulman, 1986).

In an interview with Lee Shulman at the Annual Meeting of the American Educational Research Association in Chicago in April 2007 conducted by Berry, Loughran, & Van Driel (2008) the questions that Shulman says he asked was “What is it that a teacher knows and is able to do that a specialist in the subject matter that the teacher is teaching, no matter how smart they are, doesn’t understand and can’t do? What are the sorts of things that only teachers know? That only teachers do?” Teachers are not

always aware of the cognitive knowledge they possess and use in their lessons because it may be known unconsciously or only applied to specific classes in specific contexts (Kagan, 1990) . Berry et al (2008) point out that “The foundation of PCK is thought to be the amalgam of a teacher’s pedagogy and understanding of content such that it influences their teaching in ways that will best engender students’ learning for understanding”.

The four domains of teacher knowledge that contribute to PCK as listed by Rollnick, Bennet, Rhemtula, Dharsey, & Ndlovu (2008) and defined by Shulman (1986) are knowledge of subject matter, knowledge of students, general pedagogical knowledge, and knowledge of context. Subject matter knowledge (SMK) refers to the content of the subject which any expert in the subject will have regardless of whether they teach or not. Knowledge of students is knowledge that can describe the students’ prior knowledge, their language skills, what interests them and the best way for them to learn according to their intelligences. General pedagogical knowledge is knowledge that describes good teaching practice for the context based on learning theory. Knowledge of context is information about the teaching situation like rural or urban, class size, the community in which learners live, the curriculum and time available for learning (Rollnick et al., 2008). In Figure 2.2 it can be seen that the four knowledge domains all contribute to PCK which is then manifested in the classroom as subject matter representations, curricular saliency, assessment and topic specific instructional strategies. Representations would be any representation of the content that helps learning. Curricular saliency would be tailormaking the lesson to incorporate the curriculum and how it is assessed. The importance of the curriculum and not veering off the subject would be an example of how a teacher structures the lesson so that the curriculum can be covered. Assessment refers to both assessment for learning and assessment of learning which will definitely rely on the teachers’ PCK. Topic specific instructional strategies include taking into account the prior knowledge of the learners, the resources available and the content to be addressed.

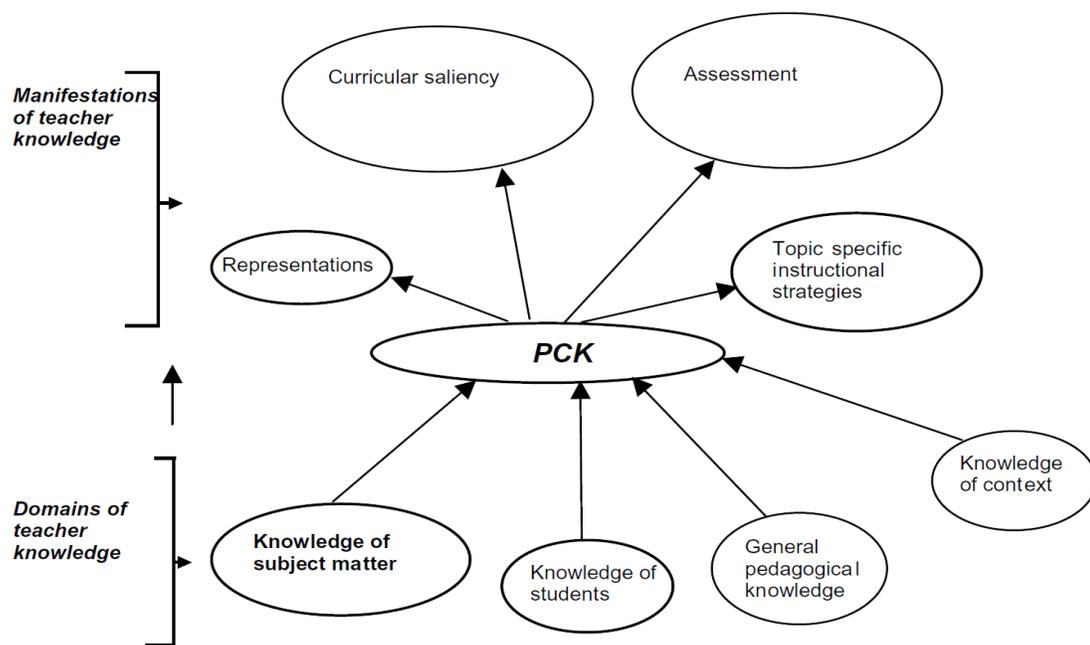


Figure 2.3: Tailored model for PCK  
(Adapted from Rollnick et al., 2008, p. 1381)

Abell (2008) refers to four characteristics of PCK which are important to take note of when trying to understand PCK. Firstly, PCK comprises of discrete categories of knowledge which when put together are used to address problems encountered in practice. Teachers use components of PCK to best solve problems that arise during instruction. The components of PCK are integrated by teachers in their planning, delivery and reflection.

Secondly, PCK is always changing and morphing according to the needs of the group being addressed, it is dynamic and organic. This dynamic nature of PCK means that PCK is constantly being built or constructed by the teacher which implies that the more experienced a teacher is, the more PCK they would have gained.

Thirdly, content is central to PCK. The starting point for the development of PCK is content. Once the content is understood, then questions about how it can be engaged with effectively in order that learning takes place can then be addressed.

Finally, PCK is not an independent category of knowledge but an integration of content and pedagogy that is used by the teacher. PCK transforms subject matter knowledge,

pedagogical knowledge and contextual knowledge into a viable construct that can be relevant, viable and applicable to the practice of teaching in order to enable learning.

If one sets out to help teachers develop professionally, as the SMILES project intended to do, then in the light of the above it is important to take into consideration the skills and knowledge that teachers already have. This is a complex process as described by Kagan (1990) but it was important for the SMILES facilitators to be conscious of the teachers' skills and abilities before offering professional development opportunities. SMILES facilitators spent the first six months interacting with and observing teachers in their classrooms prior to offering any formal learning opportunities. This served to make the training relevant and applicable to teachers at the outset of the project.

Teachers who have many years of experience are more likely to have stronger PCK than teachers who are just beginning their careers because of the dynamic nature of PCK in that it is constantly being developed in the life of the teacher. Teachers who have just completed their professional qualifications but have not officially taught full time or who have little or no experience can be regarded as novices. Much has been written about the retention of teachers and particularly novice teachers (e.g. Smith & Ingersoll, 2004; Fry, 2010; Clark, 2012; Chubbuck, Clift, Allard, & Jane, 2001; Goodwin & Judd, 2005). Novice teachers are sometimes referred to as beginning teachers. In this study they are referred to as novice teachers. Novice teachers are faced with many challenges and in many cases, if they are not supported, they leave the profession (Goodwin & Judd, 2005; Chubbuck et al., 2001; Clark, 2012). In the SMILES project schools there was a large teacher turnover in physical sciences. Three out of fifteen teachers remained in the project schools throughout the project for the full four years. During the project there were always between ten and fifteen Physical Sciences teachers involved. Some of these were involved for the full duration, others for three out of the four years and others for at least two years. Some of the teachers who left physical sciences did not necessarily leave the project as they were sometimes given other subjects to teach which were still serviced by the project. These other subjects included Natural Sciences, Mathematics and Life Sciences. For the duration of the project, Natural Sciences and Life Sciences teachers amounted to between thirteen and fifteen teachers each for both subjects. In some cases teachers who taught

Physical Sciences or Life Sciences also taught Natural Sciences. In these cases teachers had the option of attending workshops and other learning opportunities for both or either subject. The total number of Science teachers at any given stage was approximately twenty three made up of Physical Sciences, Life Sciences and Natural Sciences teachers some of whom taught more than one subject. The Mathematics teachers in the project totalled approximately twenty eight. Many of these teachers also taught some of the Sciences in their schools.

Out of the twelve Physical Sciences teachers that exited the project completely four were novice teachers. One of these left the teaching profession completely to pursue an engineering degree with a view to working in the private sector. The other three novice teachers remained in the teaching profession but went to other schools that were not part of the project. This could have been due to the fact that all of the SMILES schools served communities who were previously disadvantaged. In order to find employment novice teachers would accept the position in one of these schools in the hope of landing employment at better resourced schools later on. The three novice teachers who left the programme but remained in teaching all went to better resourced schools who were serving wealthier communities. The other eight experienced teachers who left the project either retired or were promoted to other positions elsewhere or simply transferred to other schools. The fluctuations in numbers of teachers teaching a specific subject was not peculiar to Physical Sciences but also applied to the other subjects supported by the SMILES project namely Mathematics, Natural Sciences and Life Sciences.

Of the ten to fifteen physical sciences teachers, who were involved in the project at any given time, approximately one third could be classified as novice or beginner teachers in their first three years of teaching. According to Fry (2010) induction programmes can help novice teachers adjust to their nascent roles as qualified teachers. The facilitators in the SMILES project took particular care and gave these teachers more time and support than the more experienced teachers in the programme. These programmes can be in the form of mentorships, seminars with other novice teachers and regular planning sessions with other teachers involved in the same subject (Smith & Ingersoll,

2004). Regular subject meetings were planned and the SMILES facilitators were on hand to step into novice teachers classes to give advice and help where needed.

### **2.3.2 Distinction between pre-service and Teacher Professional Learning**

The difference between pre-service training, in-service training and teacher induction is clarified by Smith and Ingersoll (2004) but they do concede that the lines are sometimes somewhat blurred. Pre-service training according to Smith and Ingersoll (2004) refers to the learning that a teacher undertakes to prepare for teaching prior to employment. The term in-service training has been replaced by teacher professional development and now more recently by teacher professional learning. Webster-Wright (2009) explains as follows: “Continuing to learn is universally accepted and expected by professionals and other stakeholders across all professions. However, despite changes in response to research findings about how professionals learn, many professional development practices still focus on delivering content rather than enhancing learning.” The change in name was partly to lay more emphasis on learning which is an active role on the part of the participant. As an example of this Power (2011) stresses that the role of the academic partner in a particular intervention was to facilitate or help teachers to develop individual learning plans. These learning plans were designed to return control of the professional learning experience to teachers writes Power (2011). The participants’ learning is emphasised as opposed to development which is a broader term.

Teacher professional learning is training received for upskilling or upgrading during employment. Induction training, however is seen as bridging the gap between being a student involved in pre-service training and becoming a teacher. In the SMILES project, which was essentially a teacher professional learning programme, some of the teachers were novices. In these instances the facilitators would take on mentorship roles as would be seen in teacher induction programmes. This is an example of where the induction training and teacher professional learning overlap. The novice teacher just qualified from university does not have the advantage of experience, but given the tools through induction can become the professional mathematics or science teacher that is desperately needed in South Africa. The mentorship given by other teachers who are more experienced gives the new teacher an advantage in the first crucial

years of teaching provided that it is based on sound practice (Jones, 2008; Fullan & Knight, 2011; Fullan M. G., 1993).

There are three main models of mentoring according to Maynard and Furlong (1995) that are predominantly found in research namely: the apprenticeship model, the competency model and the reflective practitioner model.

The apprenticeship model satisfies the need of novice teachers to experience real learners in actual teaching environments being taught applicable subject matter by an experienced teacher. Students need to be able to model themselves on someone (Maynard & Furlong, 1995). In my opinion, novice teachers often model the way they were taught when they were at school and university. Reasons for this could include: 1. this is the model of teaching they were exposed to and therefore they are most familiar with it, 2. teaching the way one was taught is generally accepted by parents of learners and teachers of that era, and 3. the most familiar method of teaching usually poses the least risk for the teacher even if that risk is perceived and not real.

The competency model according to Maynard and Furlong (1995) places the emphasis on the student taking responsibility for certain agreed upon competencies. The mentor plays the role of a coach where the novice teacher or mentee does the actual teaching, albeit using the resources of the mentor. Later these resources could be developed by the novice teacher as one of the agreed upon competences. Finally the novice will have mastered all the criteria or competences as mentored by the “coach”. The mentor will then remove their own support and encourage the student to experiment and develop his or her own teaching style.

The final model discussed by Maynard and Furlong (1995) is the reflective practitioner. This model is one where the mentor and student reflect in order to grow and improve the methods and teaching used in the classroom. Reflection by the student can lack the depth that a mentor may have and thus can also be regarded as a mentorship model where the mentor assists the student in gaining the skills to reflect deeply. Schön (1983, 1987) advocated that when teachers begin to reflect-on-action which occurs after the event and reflect-in-action during the event then they begin to develop the tools to help inform themselves and improve their work in a sustained and reflective

way. At this point the mentor can step back and the student begins to be able to reflect on their practice on their own.

Mentorship does not necessarily fall neatly into one of these models and there is usually quite a lot of overlap between the models (Maynard & Furlong, 1995). In the SMILES programme the facilitators had to nuance their mentorship role to suit the individual teacher. Teachers who were just starting their career needed the facilitators to give full lessons and then they would observe and then try to emulate the facilitator in other classes. This worked well in cases where the teacher was teaching the same subject and grade to more than one class because then the lesson could be repeated. In other cases the facilitators would co-teach or observe the teacher and then give feedback after the lesson. This would be more like the competency model. Finally facilitators would reflect with teachers regarding their lessons. Whether or not the teacher was new or experienced, this reflection took place and both facilitator and the teacher would benefit.

There would be as many different definitions for “sound teaching practice” as the number of people asked. In fact this would include all those who were taught and who do not have any tertiary qualification as they somehow feel qualified to comment by the mere fact that they were taught (Windschitl, 2002). Many think they are an expert on education because everyone has been exposed to some form of education for a very long time. Most adults today have been exposed to teaching for more than a decade. Windschitl (2002, p. 135) attests that “historically, resistance from conservative parents, school boards, and even colleges have confounded efforts to sustain progressive programs in schools”. This was seen in the SMILES project when members of one of the school’s management teams did not agree with some of the teaching methods being used. They preferred the more traditional lecture type lesson where learners sat quietly and listened to the teacher. The idea that teachers teach in the same way that they were taught is reiterated over and over again in the literature and is proved by the fact that so little has changed in education over the last few centuries (Robinson, 2010; 2006; 2013; Windschitl, 2006). Talk and chalk seems to be the modus operandi because the best teachers of today’s teachers were experts at talk and chalk. The mentors of teachers today are the teachers who taught them when they

were at school. The end result is that the methods of teaching have not changed at all even though the world has changed completely from when schools and education were first implemented. Guskey (2000) shows that to alter teachers' attitudes and beliefs is a complex process that is not simply adjusted by sending the teachers to a few training sessions. Teachers have a set of methods and ideas that they are accustomed to and they become experts in using these methods. To alter this would require proving to the teacher that the alternative method is more effective and manageable than the seemingly tried and tested comfort zone. Once the teacher tries it and sees it work in their own classroom and in their own context, only then could a change take place. Quite often this working is in the form of improved learner academic achievement. If new methods or approaches do not result in improved learner achievement, teachers may lose faith in them and revert to their comfort zones. This instrumental short term benefit expectation is fuelled by the ranking of schools according to their learner performance where the ends justify the means – whatever means, even rote learning which can achieve short term learning gains desirable for examination/assessment purposes.

This is not to say that being mentored by experienced teachers does not have value. If the novice teacher is blessed with more experienced teachers in the school, they will be able to learn much more from them besides teaching methods. The small things that one can do to make the class more manageable and the fundamentals of discipline in the class are areas amongst others where the experienced teacher is an expert which could be of great benefit to the novice teacher.

How does one then become the professional teacher that Shulman (1986; 1987) describes? The teacher is the key to changing the way education is practiced from the more traditional methods to methods that would engender critical thinking and discovery. Kazempour and Amirshokoohi (2014) state that “The success of science education reform initiatives depends considerably on the teachers.”

There is no doubt that teachers are the ones who can bring about education reform (Kazempour & Amirshokoohi, 2014), but to do that they will have to remain abreast with and be able to apply the latest educational practices through professional development opportunities.

Keeping up to date with current trends and new methods is something that professionals are required to do by the professional bodies to which they belong to. In the case of teachers in South Africa they need to belong to the South African Council of Educators (SACE). The following is the description given by SACE regarding its function: “SACE is the professional council for educators that aims to enhance the status of the teaching profession through appropriate Registration, management of Professional Development and inculcation of a Code of Ethics for all educators” (The South African Council for Educators, 2014). It is partly the duty of the teacher to see to his or her own professional growth and development and partly that of the employer as well as the philanthropist on behalf of society. The dilemma is that there are many teachers of mathematics and science who are not qualified mathematics or science teachers (Rollnick et al., 2008). Essentially these teachers need to acquire a teaching qualification and then to further their PCK could register for an Advanced Certificate in Teaching in the subject of their choice. The SMILES project could have helped teachers who fell into this category as a short term solution but the teacher would still have had to complete their formal qualifications. If a teacher were in this category SMILES would have helped the teacher register and would have supported the teacher in his or her studies as this could have had a positive effect on the learners of the teacher and the professional development of the teacher which was what the SMILES project was aiming to achieve.

## **2.4 THE PURPOSE OF TEACHER PROFESSIONAL DEVELOPMENT**

The first thing that could come to mind when someone refers to professional development is “workshops”. If positive change is what is required through professional development then “workshops” would not suffice. Workshops are just one of the many models of teacher professional development. As Desimone (2009) asserts, the professional development of teachers is embedded in their lives and is present in every single situation in which a teacher can learn something about teaching. Day, (1999) supplies the following extensive definition of professional development:

“Professional development consists of all natural learning experiences and those conscious and planned activities which are intended to be of direct or indirect benefit to the individual, group or school and which contribute, through these, to the quality of education in the classroom. It is the process by which, alone and with others, teachers review, renew and extend their

commitment as change agents to the moral purposes of teaching; and by which they acquire and develop critically the knowledge, skills and emotional intelligence essential to good professional thinking, planning and practice with children, young people and colleagues through each phase of their teaching lives.” (p.4)

The embedded character of professional development is clear in the above definition.

One of the reasons for pursuing professional development would be to effect positive change in education systems. Fullan and Knight (2011) argue that the most crucial change agents in any school system are principals and what they term “coaches”. In our context in the SMILES project, the closest we could get to a coach would be a facilitator. In the SMILES project, facilitators would be responsible for the following:

1. Planning of the curriculum to be addressed during the project
2. Planning the number, frequency and timing of contact sessions, workshops, cluster meetings and support visits in order to address the curriculum with the teachers.
3. Implementation and facilitation of all workshops, contact sessions, cluster meetings and school visits.
4. Reporting and reflecting on of all activities to the project manager.

### **Planning of the curriculum**

Facilitators strove to make the content of all sessions with the teachers they were serving as relevant and applicable as possible. One of the main considerations for the facilitators was which content would be most relevant to most of the teachers in the project at any given time. Physical Sciences is taught in grades ten, eleven and twelve and these three grades form the Further Education and Training Band (FET). In the FET the concepts and skills that learners have to master are developed over the three years. For example “Waves, Sound and Light” is one of the themes covered in the FET in all three grades. In each grade different aspects are dealt with and developed. These concepts build on each other hierarchically. A complication for facilitators was that not all grades or schools were dealing with the same body of work at any given time. From the above it is clear that planning the curriculum of what to do when with the teachers during whichever sessions was not a straightforward task.

### **Planning the number, frequency and timing of sessions**

The number, frequency and timing of workshops, cluster meetings and school visits had to be determined by the facilitators. This was based on the knowledge of the school contexts and on what was happening in each of the schools at any given time. Scheduling classroom support visits during examination periods for instance would have been a waste of time. Facilitators therefore had to have a very good understanding of the contexts and the factors that were influencing teachers in order to get the timing and frequency of the sessions right.

### **Implementation and facilitation**

Facilitators had to source, develop and deliver all material used during all of the sessions. In the Physical Sciences sessions this would include all apparatus chemicals and teaching aids that were necessary for the event. The venues for the sessions had to be suitable for the conduction of practical hands on experiments and activities. These venues, although sourced by the administrative support staff, had to be vetted by the facilitators to ensure their suitability for the particular session.

Facilitators were also responsible for all school support visits to teachers in their classrooms. It is in this sense that the facilitators in the SMILES project had a similar role to the coaches to which Fullan refers. The SMILES facilitators had to arrange suitable times to visit teachers when they would be teaching Physical Sciences. It was during these visits that the facilitators would help the teachers implement the ideas and work covered in the workshops. Fullan & Knight (2011) report the following:

“The coaches typically spent their day planning lessons with classroom teachers, modelling lessons, observing instruction, facilitating meetings, reviewing student data, and leading the collaborative marking of student work.” (p51)

The facilitators would do precisely these things during school visits. In addition to this they would also advise and help with the setting of assessment activities.

### **Reporting and Reflection**

Every quarter facilitators handed in a report which primarily informed the programme manager of the activities of the project. The secondary purpose for the quarterly reports was that it was used as a tool for facilitators to reflect on their activities in the

project. This formed the basis of project meetings where once again facilitators were encouraged to reflect on the project and what changes could be made to improve the offering.

Thus the facilitators who planned, facilitated and ran learning sessions with teachers were also the “coaches” who visited and supported teachers in their schools after the learning sessions. They are mentors and have the capacity to guide and help teachers develop professionally using a blend of the mentorship models outlined by Maynard and Furlong (1995) above. These facilitators have taught and worked in a variety of settings and therefore understand intuitively that context is all important if effective professional development is to take place.

Fullan and Knight (2011) report that successful coaches spend their day with teachers helping them throughout the process beginning with planning lessons, co-teaching, observing lessons, moderating student work and facilitating meetings. In order for all this to take place the facilitator would have to become an integral part of the school and be totally accepted by the teachers who are being helped. Indeed facilitators need to have a strong relationship with their teachers if they are to be welcomed into the class in the first place. Facilitation in this sense is not coaching, it is also not evaluating or examining, rather it is supporting and helping in order to make each lesson given a rich learning experience for the client.

One of Fullan and Knight’s (2011) fourteen parameters for success to improve student’s achievements is the professional development of the teacher. Advancing the career of the teacher or exposing teachers to professional development opportunities through formal qualifications, accredited short courses and support projects therefore can also be seen as a vehicle to ultimately improve students’ academic achievements. Ultimately the goal of any teacher development whether it is in-service or pre-service must be to equip teachers with the necessary knowledge, skills and tools to teach. In chapter one it is outlined that the education system can be no better than its teachers. If the crisis in education is to be addressed in order that South Africa can become a global economically and technologically advanced competitor then the professional development of the teacher is of paramount importance. The benefits of an advanced

education sector are manifold according to the world economic reports outlined in Chapter 1.

## 2.5 CHARACTERISTICS OF EFFECTIVE PROFESSIONAL DEVELOPMENT

It is agreed by many that the characteristics that define effective teacher professional development are many and complex (e.g. Guskey, 2003; Postle, Edwards, Moon, Rumsey, & Thomas, 2002, Desimone, 2009). The researcher will attempt to highlight the key factors that influence professional development as gleaned from the literature. The list cannot be exhaustive as the field of professional development is constantly growing, but the factors that are listed are those that are mentioned frequently.

The following characteristics of effective in-service education are listed by Courtney (2007) and were applied to a project that was implemented in Cambodia.

“In-service education:

- can be viewed as a vehicle for change management...;
- serves a different purpose in developing countries compared with the rich countries where many of the models and pedagogies are initially generated;
- is part of a process that includes follow-up and support structures within a school;
- starts with and builds on the existing local context;
- must be practical, appropriate to the audience and replicable in classrooms; and
- is developmental and cyclic in nature.”

(Courtney, 2007, p323)

Firstly, the most fundamental reason for professional development in any profession is to, as the name implies, change that profession from what it currently is to something more qualitatively advanced. Hopefully that change or development is positive. The researcher agrees fully with Courtney, that in-service education can be a vehicle for change management from traditional pedagogy to reform-oriented mathematics and science teaching. This is also in line with Fullan & Knight’s (2011) argument that coaches are crucial change agents in an education system. Their sole function is to help the teacher develop professionally for the good of the system and to change the system for the better. Firstly, for Courtney (2007) in-service education refers implicitly

to professional development as any new learning or knowledge gained from in-service education to develop the person professionally.

Secondly, Courtney is implying in the second bullet above that professional development must be nuanced according to the context. It cannot be something that was developed out of context hoping that it would work in all possible scenarios – or universal set of contexts. The generic one size fits all is not possible when it comes to professional development or in-service education.

Thirdly, in-service training is not just something that happens at a workshop or contact session. It must include the third bullet - follow-up and support. It is a process that will take time and not just a one stop shop or destination. This support can also come from structures within or from without the school. A single contact session without follow-up or any kind of support or buy in from the school can be a receipt for failure.

The fourth bullet ties in with the second in that the people within the context must identify their needs. Professional development must start where teachers are, first use what is immediately available and build that up to an acceptable standard. Using existing structures will also help the teachers who are being helped to identify with the professional development offering seeing as it uses familiar structures. Roesken (2011) states that even if professional development events, are carefully and thoroughly planned, theory driven, designed and conducted in a well composed way, it is still ultimately up to the teacher to decide whether a program is suitable or not. The teacher has the choice to take part or not and essentially this decision will be based on whether they see the intervention as useful or not.

Professional learning that cannot be practically applied immediately in the context will probably never be applied. By saying it must be practical, appropriate and replicable, Courtney is considering that if the learning cannot be applied in the school to affect student learning outcomes then there is no point. This stance is supported by others like Guskey (2000) and Desimone (2009). Take up by teachers will be so much higher if these requirements are met.

Finally the developmental and cyclic nature of teacher professional learning implies that there is always room for improvement. Professional development must therefore be viewed as an ongoing process which lends itself to life-long learning.

### **2.5.1 Time spent on Professional development**

Guskey (2003) acknowledges that professional development requires time but emphasises that the time must be “well organised, carefully structured and purposefully directed” (Guskey, *What Makes Professional Development Effective?*, 2003, p. 749). When people feel that the time that they are investing is being wasted the likelihood of them gaining from the experience diminishes. Just spending the time in order to tick off the checklist that a certain number of hours was spent on professional development could be counterproductive. Time for reflection by the participants or rather the person undergoing the professional development makes it easier to locate the knowledge or learnings gained in the context in which they work (Postle et al., 2002). Reflection, being a higher order skill is often overlooked and not given enough time in professional development courses and interventions. It is however one of the most crucial aspects of professional development as it will help the student assimilate the inputs into their own context and to own it.

### **2.5.2 Collaboration between teachers in different schools in the project**

Structured, purposeful collaboration with clear goals for student learning should be characteristic of the collaboration among teachers who are seeking to develop professionally (Guskey, *What Makes Professional Development Effective?*, 2003). Guskey adds that collaboration must not just be between teachers who are on-site and therefore have critical contextual knowledge, but must also include district officials who have a broader view of problems facing other contexts. If district officials are engaged and support the initiative it will have a greater chance of being accepted more widely and therefore having more impact (Guskey, 2003). In the SMILES project the WCED was involved in the broad selection of schools who could take part in the project and after that was done the district offices were informed of the project and what it would involve. District officials were met with annually at the SMILES cluster meetings to

keep the lines of communication open. It must be said that when we did need help from the district it was immediately given. In retrospect there could have been more interaction with the Curriculum Advisors in the FET and Senior Phase especially when it came to the presentation of workshops and other learning opportunities. The Curriculum advisors in the General Education and Training (GET) band attended workshops and could give valuable input at these events.

Collective responsibility for professional development lies with both the service provider and the teachers or recipients of the service (Postle et al., 2002). Postle et al. (2002) assert that the institutions who release their staff for professional development initiatives need to be involved in collaborative work with the service provider to ensure effective outcomes in the workplace. In SMILES project context this workplace is the school. They take it one step further and say that if professional development is to be effective, then learning must take place not only during contact sessions with the service provider but in the institution of practice as well. This ensures a greater uptake of the content and skills covered in the contact session. Effective transfer of learning from one setting to another is challenging but collaboration between the service provider and the teacher will go a long way to make that transfer more possible.

### **2.5.3 Assessment**

Assessment of students attending courses for their professional development could include an assignment which is practice-based. This will ensure that the ideas and learning that were shared during the contact session are applied at least for the assessment and in so doing the teacher may realise the value of the professional development.

Collaboration with the teachers when designing the professional development initiative or when identifying the content of the contact sessions is necessary to ensure that the session is relevant and apt for the teacher (Postle et al. 2002). Attendance of a course when the content of the course is not needed or relevant will result in minimal take up. By collaborating with the teachers before the content of the course is fixed will ensure that the content is relevant to the teachers' needs. This view is endorsed by Valera

(2012) who urges that teachers should be involved in the selection of the activities that they will attend based on their own identified needs. In the same way that teachers need to take the strengths and weaknesses of their learners into account when teaching, so the officials and service providers of professional development should also take the strengths and weaknesses of the teachers into consideration. Generic in-service training goes against the concept of differentiated learning.

#### **2.5.4 Context in which school is placed**

Because effective professional development takes place in real world contexts in schools where the teachers are based it is imperative that the context in which teachers operate must be taken into account (Guskey, *What Makes Professional Development Effective?*, 2003). A professional development initiative could fail dismally in one context and thrive in another. Guskey (2003) cites an example of when the same initiative is used in well-resourced schools and under resourced schools the project may fail because the contexts are so different.

In the under resourced school teachers would be looking at cheap alternative ways to make the curriculum accessible to their learners whereas in more affluent schools this would not be an issue. If the professional development initiative always uses state-of-the-art equipment, then teachers from under-resourced schools will be excluded, or would find the initiative less valuable. By the same token teachers from well-resourced schools may find little value in attending a session where “shoestring science” apparatus is used as the tools for exposing the curriculum when they have all the equipment needed already. At the outset of the project, the SMILES schools had some equipment but not everything that they needed. Initially shoestring science apparatus was used until the science apparatus was ordered and delivered to each school. The teachers still wanted to know how to do the different experiments in a cheaper way as they felt that if the apparatus was damaged they would still be able to perform the demonstrations and investigations.

Under-resourced schools have more trouble attracting well qualified and experienced teachers than their more affluent neighbours. An intervention aimed at an inexperienced less qualified teacher would have to look very different to the professional development offered to the experienced well qualified teacher (Guskey,

What Makes Professional Development Effective?, 2003). The SMILES project targeted under-resourced schools and as such some of the teachers on the programme were new or less qualified. There were however very experienced and very well qualified teachers which meant that the professional development opportunities had to cater for both ends of the spectrum. Here it was found to be helpful to pair off the more experienced teachers with the newer novice teachers. Towards the end of the project some of the more experienced teachers even facilitated a workshop on assessment for the project.

### **2.5.5 Relevance of professional development for teachers**

Teachers need to see the immediate value of the work covered during professional development contact sessions otherwise very little will be implemented (Postle et al. 2002). If teachers were not confident in handling the apparatus or the chemicals that were used during professional development sessions then we rarely saw them demonstrating these experiments to their classes. In order to build the teachers confidence and skills they were required to do the experiments and demonstrations themselves as if they were doing it in their classes. The value of what they were learning was recognised as they began to understand the SMK by doing the various practical activities applicable to the concept being studied.

Professional development that is relevant to the classroom and is embedded in the classroom practice is highlighted as key (Varela, 2012). Professional development works best when it is modelled in situ and not a theoretical exercise done out of context. Valera continues by saying that when the professional development is carried out in isolation of classroom practice it merely becomes part of the teacher's "contractual obligation". In the SMILES project all of the work covered was embedded in classroom practice and practically delivered and implemented. Some of the professional development took place in the form of mentorship in the teachers' classroom. When workshops were given, the material would always be made available in a format that could be used directly in the classroom. Teachers had the freedom to change this material to suit their context but the need to do this was rare.

### **2.5.6 Sustained input**

Ongoing and sustained development initiatives are more likely to achieve results than once off workshops. A partnership should be built over a sustained time between the service provider and the teachers who are benefitting from the professional development (Varela, 2012).

## **2.6 CORE FEATURES OF TEACHER PROFESSIONAL DEVELOPMENT**

As the SMILES project is an example of teacher professional development, the core features that make up teacher professional development are considered in this section. The application of these features to the SMILES project is also made clear.

Desimone (2009) argues that understanding what makes professional development effective is critical to understanding the success or failure of many education reforms. This statement was relevant to the SMILES project which was a systemic intervention effort. Every situation that a teacher finds themselves in, is a potential learning opportunity because professional development is on-going and a part of a teacher's professional life (Desimone, 2009; Guskey, 2000; Roesken 2011). The SMILES project attempted to work with every aspect of the teachers professional life by getting involved with material development, common assessment instruments, mentorship in the classroom, teacher learning opportunities and extra tuition for learners to name a few. This intervention was implemented over four years with frequent regular project events taking place throughout the year. Roesken (2011) proposes that the focus should be on teachers' lifelong and continuous learning, in-service training offers are supposed to be of long-term orientation, job embedded and aligned with a teacher's actual job. This is consistent with the view of professional growth as a lifelong learning process.

During each lesson the teacher is exposed to new ideas that could influence their teaching practices for the next lessons. This is essentially what professional development is, the changing of teaching practice in order that learning takes place to positively influence student learning outcomes. The discussions in the corridors with other teachers, the meetings in the staff room, reading a book, or attending a workshop specifically designed to address teacher professional development are all examples of situations that could positively influence a teacher's professional development. Finding

the criterion that makes professional development of teachers effective is the challenge that Desimone took on and she argues that there are five core features associated with professional development that make it effective. The features of professional development are what is important and not necessarily the structure or model of professional development (Desimone, 2009). Any of the structures could contain all the features whether it be a workshop or a conversation in the corridor. She says that “given the number, quality, and diversity of studies that provide support for the features” that consensus has been reached regarding these core features of effective professional development. The core features to which she refers are a) content focus, b) active learning, c) coherence, d) duration, and e) collective participation.

Content focus refers to using content in order to address teaching skills and teacher practice. By just addressing the theory of the skills or the teacher practice and not applying it to content that the teacher needs to cover makes it more difficult for the teacher to apply. As Courtney (2007) said, the work done in professional development needs to be directly applicable in the classroom. As soon as content is brought in it gives the teacher something to link the teaching theory or skill to. This will in turn make it easier for them to reproduce or use in their classroom setting. In the context of this study the content focus was SMK in mathematics and the sciences.

Active learning can be achieved through classroom discussions that include interactive feedback, debate, reflection and presentations of new knowledge by the participants to everyone. Listening passively to a lecture does not compare with a session where the participants are actively engaged in learning. Analysing a recorded lesson or a live lesson collectively might help teachers to look objectively and critically at teaching practice in an active way that could be far more effective than passively listening to a lecture.

Coherence refers to whether there is consistency between what is offered in the professional development and the education policy that teachers are subject to. If the message that is given to the teachers by the curriculum advisors is different to the message given by the facilitators of the professional development opportunity, then it is unlikely that what the facilitators espouse will be applied in the classroom as the teacher is bound to teach according to the Education Department’s policies and

curriculum. If there is consistency between the Education Department's policies and the professional development content then teachers see it as support and are more likely to apply what they have learnt in their schools.

Duration of professional development and the frequency of events is a feature of effective interventions highlighted by Desimone (2009). Guskey (2000) and Supovitz & Turner (2000) also endorse this view. Professional development that is sustained and has frequent inputs is more likely to achieve a learning culture in the schools than interventions where the contact time is limited to a once off event (Supovitz & Turner, 2000). The duration of the professional development depends on a host of factors in order to be effective. These factors include the existing expertise of the teacher, the content of the professional development and the context in which the teacher operates amongst others. Supovitz & Turner (2000) found that there were significant changes in teaching practice after eighty hours of professional development while changing the classroom culture took double the amount of time. In the SMILES project the aim was to spend 60 hours per year over four years on the professional development of the teachers. This amounts to a total of 240 hours which is 80 hours more than what Supovitz and Turner (2000) found to be adequate for changing the classroom culture. It must be added that a complicating factor was that not all of the teachers remained in the project and therefore were not exposed to the full 240 hours of professional development.

Collective participation occurs when teachers from the same school or district are involved in the same professional development activity (Desimone, 2009). When teachers from the same grouping or area are attending the same course or intervention this immediately sets up learning communities amongst the teachers. These learning communities could potentially establish opportunities for dialogue and discussion about the professional development just because they have the district or school in common. Within these communities there is huge potential for learning to take place as they share with each other. In support of collective participation, Roesken (2011) states that "professional development is not simply an individual endeavour but is most powerful in terms of collaboration particularly among subject teachers of the same school". In some cases there may only be one teacher who presents a certain subject but then

that teacher could collaborate with others in neighbouring schools or districts. This was indeed the case for the physical sciences teachers in the SMILES project and because of this they ended up networking together immediately after the first professional learning opportunity.

Desimone (2009) proposes a conceptual framework for studying teachers' professional development which lists four interactive non-recursive relationships between professional development, teacher knowledge and beliefs, classroom practice and student outcomes. The professional development includes the core features discussed above and is illustrated in Figure 2.3 below.

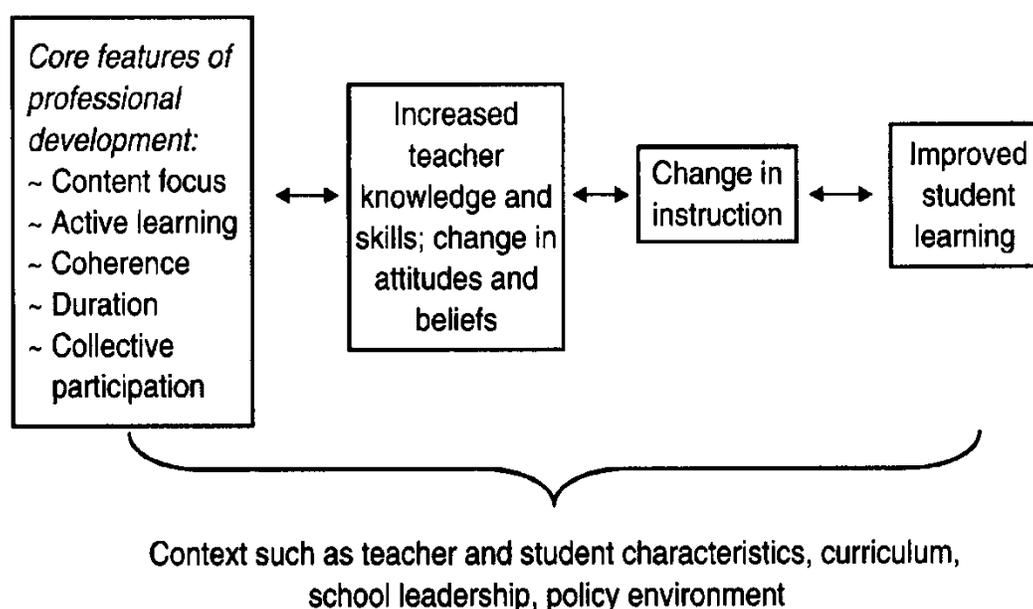


Figure 2.4: Desimone's conceptual framework for studying the effects of professional development of teachers and students (Adapted from Desimone 2009, p. 184)

Starting with effective professional development which includes the core features above, Desimone (2009) argues that the increased teacher knowledge would lead to a change in attitudes and beliefs. When the teacher has a change in attitude or beliefs it should follow then that the practice in the classroom will change. If the change in instruction is effective and sustained then learners' results and learning should improve. All of this happens in a specific context which acts as a mediator and moderator. If the context is a dysfunctional school it is obvious that the best professional development intentions will be likely to fail. Having said this, it is possible

that teachers can effect change in the school even when the school is dysfunctional but it will take an extraordinary amount of effort to accomplish this.

A professional development programme designed with these criteria in mind would then begin to change teachers' attitudes and beliefs or knowledge and beliefs which in turn should bring about a change in classroom practice to affect student outcomes. Desimone (2009) goes on to say that different emphasis could be placed on the different components of the conceptual framework and the model is mediated by the context in which it operates.

## **2.7 GUSKEY'S LEVELS OF PROFESSIONAL DEVELOPMENT EVALUATION**

Desimone's four steps link well with Guskey's (2000) five critical levels of professional development evaluation. These are participants' reactions, participants' learning, organisational support and change, participants' use of new knowledge skills and student learning outcomes. Participants' reactions to professional development are the beginning of the conceptual framework which starts with effective professional development. Professional learning links in with teacher knowledge or attitude and beliefs. Organisational support and change and the participants' use of new knowledge skills ties in with classroom practice. Finally both refer to student learning outcomes. In this study this will form the framework which is used to present the SMILES intervention and its evaluation.

According to Guskey (2000) there are five levels of professional development evaluation information that should be considered. Each level builds on the one before and they become increasingly more complex.

At the first level the reactions of the participants to the learning opportunity are measured. This would typically be measured at the end of a session by asking participants to fill in a questionnaire. This questionnaire would contain questions like: "Was your time well spent?", "Did you understand the material/facilitator?", "Was the facilitator helpful?" and any other questions regarding the logistics of the session. The point of this would be to try and improve the format of the training to better suit the participants. Evaluation forms were filled in after each workshop but soon it became

apparent that the teachers were overwhelmingly positive about the workshops and had nothing more to add. This data has not been analysed in this study as the results were consistently excellent. An overall evaluation questionnaire was subsequently set up and this was analysed to give a few of the teachers' perceptions of the project as a whole.

At the second level of professional development evaluation the participant's learning is evaluated through pencil and paper activities, observing participants skills acquired, reflection of participants and participant's portfolios. During workshops teachers were observed whilst they carried out the various activities, but these observations were not documented and as such could not be analysed in this study.

At the third level of professional development evaluation the degree to which the participants are supported by the school or district in which they work is measured. Interviews with school management teams and district officials could inform this level. Cluster meetings with subject teams and the examining of minutes taken at these meetings could also be a valuable source of information for this level. In the SMILES project the principals of all the schools were interviewed regularly and the teachers met in cluster meetings on an annual basis. The meeting that was recorded for this study was between the project manager and the principals at the end of the project's third year. If the teacher is not supported systemically to implement the knowledge and theory gained by attending the professional development sessions then the programme's effectiveness is essentially a non-starter. The lack of systemic support is not an indication of the quality of the programme or the format of the programme, it just makes it the knowledge gained very difficult to implement. Lack of organisational support is also not an indication of whether the participant gained new and useful knowledge or not. It is merely an indication that the environment in which implementation of the new knowledge is not favourable.

At the fourth level of professional development evaluation the participant's use of the gained knowledge and skills is examined. This is the level where one will ascertain whether the material shared with the participants is being used for its intended purposes or not. The obvious method for finding this information would be through

direct observation. Analysis of lesson plans, interviews with participants and examining portfolios can also inform this level. In the SMILES project facilitators would observe teachers in their classrooms and mentor them accordingly. Any reflective feedback was shared with the teacher and the project management team, but these discussions were not documented. Biputh and McKenna (2010) discuss the effects that inspections by Education Department officials had on teachers in South Africa prior to 1994 and the negative response it invoked. Observations of lessons that were undertaken in the SMILES project took on more of a mentoring role of support and guidance than one of inspection or evaluation. The role of the facilitators doing the classroom visits was to nurture, support and guide the teachers to be able to apply the skills and knowledge gained during contact sessions or workshops. The observations made were discussed but it was decided not to mine this for research or evaluation as the positive relationship that facilitators had with the teachers could have been threatened and therefore could have put the entire project at risk.

At the fifth and final level of professional development evaluation the concern is about student learning outcomes. It is the level that funders, education authorities and the public are most concerned about: Did the professional development of the teacher have a positive effect on the learning outcomes of the learner or student being taught? Were the student learning outcomes achieved as a result of the professional development? Although causality is always difficult to prove in a school setting because of the many variables that affect student performance, improved student achievement is the ultimate litmus test for teacher professional development effectiveness. Scores in standardised tests and examinations of the students are the obvious proxy measures for this level. Other indicators on the affective domain could include students' attitudes towards their work, levels of absenteeism and their perceptions of how the programme affected their learning and understanding. This information could be collected using structured interviews with learners, examination of school records of each student and analysing results achieved in tests and examinations. In the SMILES project learners were interviewed and given a questionnaire regarding their perceptions of the project and if their understanding was deepened regarding their schoolwork. These results are discussed in Chapter four. The results from the NSC for all the schools were also obtained and these were

analysed and compared with those of the province and the rest of the country. The comparison with the national and provincial results also served to control for the factors that were common nationally and provincially with the project schools.

Guskey and Yoon (2009) set out to review and summarise findings of the American Institutes for Research regarding the effect of professional development on student learning outcomes. They were discouraged to find out that only nine out of 1343 studies met the standards of credible evidence required by the What Works Clearinghouse (WWC). WWC is part of the US Department of Education and their role is to provide all stakeholders with scientific evidence regarding what works in education. They contend that although some feel that the standards set by WWC are “unduly rigorous”, the answers to what works best in professional development of teachers, should be the most valid and scientifically defensible evidence available.

Guskey and Suk Yoon (2009) report that workshops have been labelled and criticized as the epitome of ineffective practice, particularly the kind that takes place in a short time with no follow up or support. Having said this then would imply that workshops that are held over longer periods with a more sustained support built in would fare better than the hit and run variety. The workshop idea is not completely condemned as they go on to say that all of the studies that showed a positive influence on student performance included workshops. In the SMILES project workshops formed the core of the intervention. In the analysis by Guskey and Yoon (2009) it was found that the number of contact hours ranged from 30 to 100 hrs of those interventions that were deemed successful by WWC. The SMILES project worked on the basis that the contact hours would be in the region of 50 or 60 hrs per year of the project. This amounted to over 200 hours which, according to Supovitz and Turner (2000) would be enough to change teacher practice as well as classroom culture.

In the SMILES project the facilitators all had extensive teaching experience in a variety of settings and thus were easily accepted by the teachers in the schools. The facilitators did not pose as so called experts but instead rather saw themselves as colleagues who were there to support rather than evaluate. Biputh and McKenna (2010) show that the teachers who used to teach in South Africa during the apartheid

era viewed inspections from subject advisors with a great deal of suspicion and distrust. Negative forms of appraisal dominated to the extent that teachers and schools reacted violently to the authorities' reports (Biputh & McKenna, 2010). The teacher unions continue to reinforce this in schools and have to a large degree succeeded in keeping department officials out of the teacher's classrooms.

In the analysis done by Guskey and Yoon (2009) it was found that the successful projects, those that were among the nine selected by WWC, relied on outside expertise. Clearly in the SMILES project the best of both worlds was used. Facilitators were teachers themselves and knew the classroom environment. They knew the type of schools in which we were working and had served as teachers in schools like the ones chosen for the project.

Guskey & Yoon (2009) contend that follow up is critical to any training that was given in order to support the trained teachers. This would be level 4 according to Guskey's hierarchy of professional development evaluation. They say that all teachers needed on the job support as they struggled to adapt to new instructional practices. In the SMILES project, facilitators visited teachers in their classroom at least five times per year during which they co taught, observed, taught and then reflected after each session with the teachers. SMILES facilitators also conducted extra lessons in the afternoons with learners to further enhance the follow up support as well as to directly try to influence the understanding of the teachers as to how to embed and use the instructional practices given in the workshops.

## 2.8 CONCEPTUAL FRAMEWORK FOR THIS STUDY

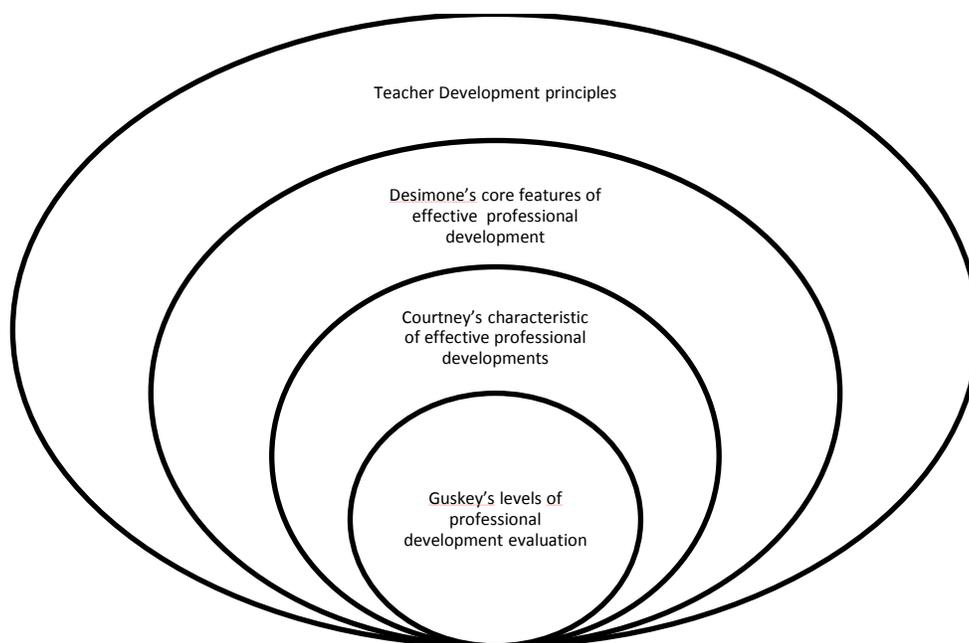


Figure 2.5: A conceptual framework for this study

Figure 2.4 show the conceptual framework for this study. The teacher development principles in the outer circle are the result of the three different theoretical constructs on the inside. Guskey's (2000) inner core is the starting point where one asks what it is that must be put in place to ensure that the fifth level of evaluation is reached. Courtney's (2007) characteristics of effective professional development further describes the necessary components that need to be put in place when designing effective professional development. Desimone's (2009) core feature complete the picture and then move the model to a change in teachers' beliefs and attitudes to effect a change in classroom practice followed by an improved student outcome

## 2.9 CONCLUSION

In this chapter literature pertaining to teacher professional development has been reviewed. Constructivism, the nature of science, scientific argumentation, and PCK were discussed and applied to the SMILES project. The differences between pre-service teaching and teacher professional learning and the areas where they overlap were unpacked with special reference to novice teachers. The purpose, characteristics and core features that typify examples of effective professional development were explained and applied to the context of this study. Finally the five levels of Guskey's (2000) professional development evaluation were shared and unpacked. The

evaluation of the SMILES project in this study uses this as a framework and the data presented is categorised according to these five levels.

In the next chapter the methodologies used in sourcing the data for the SMILES project are presented and discussed.

## CHAPTER 3

### RESEARCH METHODOLOGY

#### 3.1 INTRODUCTION

In this chapter the research design and methodology of the investigation regarding the SMILES project will be discussed. Data collection methods and the sampling methods will be described. The different instruments used in this research will be described and the reasons for using both quantitative and qualitative data will be unpacked. A summary will conclude the chapter.

#### 3.2 RESEARCH DESIGN

In order to evaluate the SMILES project both qualitative and quantitative methods were used. By using both methods a more complete picture is sketched. This mixed method approach has the advantage of giving a richer and fuller understanding of the topic being researched as it uses different sources of information to describe the same phenomenon or topic. David Plowright (p18, 2011) suggests that to describe numerical data one does not need to be restricted to mathematical and statistical analyses, or to describe qualitative data one is not restricted to theme analysis. One could use a narrative to describe quantitative data or transform qualitative data into numerical information. Describing quantitative data using a narrative or qualitative methods is well known. However, quantizing, commonly understood to refer to the numerical translation, transformation, or conversion of qualitative data, has also become a staple of mixed methods research (Sandelowski, Voils & Knafel 2009).

Johnson, Onwuegbuzie, & Turner (2007) define mixed methods research (MMR) as follows:

“Mixed methods research is an intellectual and practical synthesis based on qualitative and quantitative research; it is the third methodological or research paradigm (along with qualitative and quantitative research).” (p. 129)

This definition was formulated after looking at nineteen different definitions that leaders in the field of MMR produced. From the definition it is clear that both quantitative and qualitative research is involved, but to what extent each of these types of research feature in MMR cannot be fixed. Instead Johnson et al( 2007) propose that MMR lies on a continuum between qualitative research and quantitative research. Figure 3.1 illustrates this idea graphically.

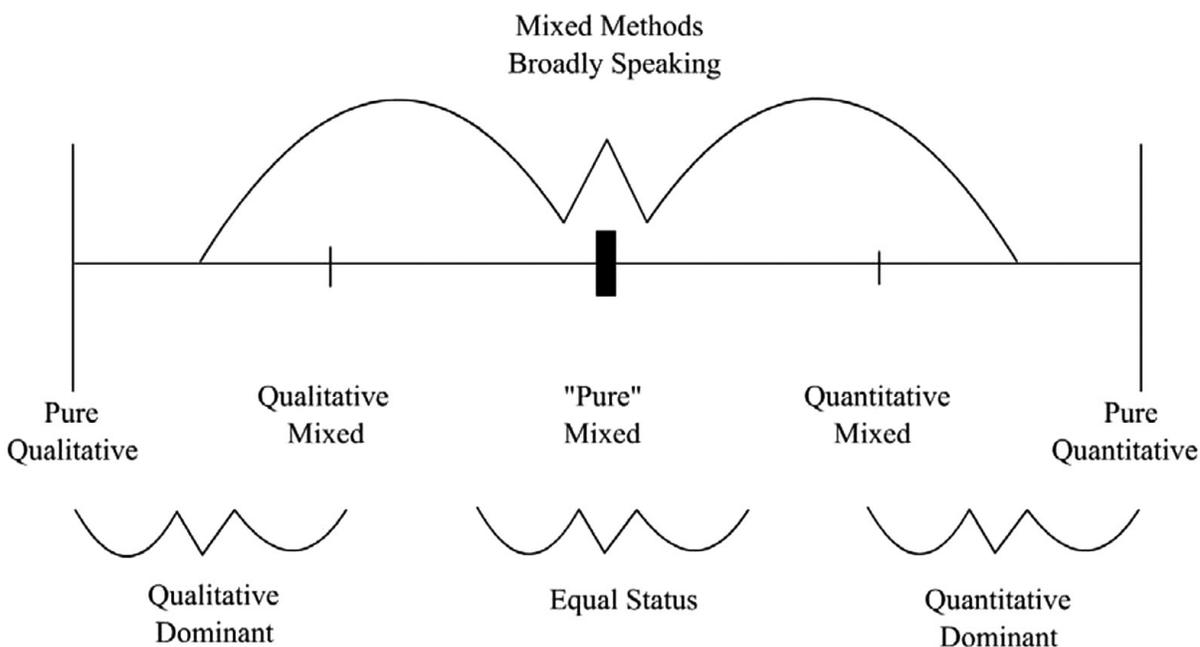


Figure 3.1: Graphic of the Three Major Research Paradigms, including Subtypes of Mixed Methods Research (Adapted from Johnson et al., 2007)

Figure 3.1 shows that there is considerable overlap and room for all forms of MMR. The area in the middle of the continuum excluding the extremes is the domain of MMR. Within this area there could be three main subdivisions. If the research is dominantly qualitative but has some of the features of quantitative research, then this would fall into the “Qualitative Dominant” area. If, however it is more quantitative and uses some features of qualitative research then it would be “Quantitative Dominant” on the continuum. When both forms of research are equally dominant then it would be regarded as “Pure Mixed” or “Equal Status”. This study is an example of using equal status as thick descriptions and numerical data was used to roughly the same degree. When time allowed for open ended questions the qualitative methods were used. If however time was limited then the Likert questionnaire would have been more apt.

Cameron (2011) claims that during the 1980s, debates surrounding research paradigms were particularly active and these debates began to become known as “The Paradigm Wars”. Academic journals also favour certain research paradigms, but there is a growing number who are focussing on the MMR paradigm (Cameron, 2011). Schwandt (2000) had the following to say:

“All research is interpretive, and we face a multiplicity of methods that are suitable for different kinds of understandings. So the traditional means of coming to grips with one’s identity as a researcher by aligning oneself with a particular set of methods (or being defined in one’s department as a student of “qualitative” or “quantitative” methods) is no longer very useful. If we are to go forward, we need to get rid of that distinction.” (p. 210)

I agree with Schwandt in that all research is interpretive whether or not qualitative or quantitative research paradigms were used. In this study the dominant research paradigm is qualitative and the sub paradigm is quantitative. Quantitative representations (e. g. bar graphs and word clouds) are used to describe data that was collected using qualitative techniques such as interviews and surveys.

The philosophy of left pragmatism refers to pragmatism which favours pluralism strongly and realism to a lesser degree. Right pragmatism favours realism and less so pluralism (Johnson et al., 2007). Johnson et al. (2007) argue for what they call “pragmatism of the middle” as a philosophy for MMR. The “fundamental principal” of MMR referred to above is that researchers can collect data using different strategies, methods and approaches from the different research paradigms and then mix them in order that the final product will contain the complementary strengths of the different paradigms. (Johnson & Onwuegbuzie, 2004)

Denzin (1970, p. 291) distinguished between four types of triangulation, a) data triangulation which refers to a variety of sources for the study, b) investigator triangulation meaning that different researchers collect data from the same source, c) theory triangulation is the utilisation of different theories to interpret the data, and d) methodological triangulation is triangulation that uses different methods to study or analyse the data. Morse (1991, p. 120) divided methodological triangulation into two

further types, simultaneous triangulation and sequential triangulation. Simultaneous triangulation occurs when the data is collected using both quantitative methods and qualitative methods at the same time. The collection of this data does not have to take place in a particular sequence. Added to this the quantitative data does not depend on the qualitative data and vice versa. Sequential triangulation is utilised when the results of the one method are needed to plan the next. In this case the order the methods of data collection are important. The order, however could be any way around, quantitative first and then qualitative or qualitative first and then quantitative. In this study simultaneous triangulation when data was collected from the learners. The questionnaire that they filled in was analysed using quantitative methods while the open ended questions used both quantitative and qualitative methods. The word clouds used are examples of how the frequency of the most common words are highlighted. When using their quotes verbatim it was an example of qualitative research. The methodological triangulation was chosen because the researcher wanted to be sure that every aspect of the teacher learner sessions were captured giving the opportunity for thick descriptions as well as numerical manipulation.

Triangulation, especially methodological triangulation is one of the often cited reasons for using MMR. (Cameron, 2011; Gay, Mills, & Airasian, 2006; Johnson, Onwuegbuzie, & Turner, 2007; Johnson & Onwuegbuzie, 2004; Creswell, 2009; Mertens, 2005; Schwandt, 2000)

A naturalistic or qualitative evaluation tradition will be predominantly used as, amongst other conditions listed by Babbie and Mouton (2001, p. 357), the purpose of the evaluation is formative and developmental in nature (improvement-oriented) rather than summative. The explanatory role of this study will serve to inform what aspects of the project were effective and why, which were not and which ones were partially effective. A cut and dried “yes” or “no” was not the aim of the study but rather to inform whether the model used was successful or to what extent it was not so as to shape possible future projects.

Babbie and Mouton (2001, p342) agree that the sooner evaluation takes place in a project the better and hence the need to evaluate as soon as possible. Surveys were given to the participants immediately after each workshop. This was done from the

beginning of the SMILES project. These workshop evaluation surveys served the purpose of informing the facilitators and project management of whether the teachers were finding the workshops relevant and useful. Essentially this was evaluation at Guskey's (200) first level as discussed in chapter 2 section 2.9. The funders of the SMILES project gave the freedom to the service provider to change the model over the life of the project, different research methods were used to inform the model at different stages. The funding was allowed to be channelled according to where the greatest need was or where the greatest impact could be made.

### **3.2.1 Selection of Schools in the SMILES project**

Given (2008) explains that the process of defining the population out of which the sample will be selected is known as purposive sampling. A set of criterion defining the population is set and this is referred to as purposive sampling. At the outset the service provider requested from the local provincial education department (Western Cape Education Department) a list of schools that could benefit from a project of this nature. The requirements that the schools had to meet to be considered were a) they had to be have a pass rate of more than 60% meaning that at least 60% of the learners who the National Senior Certificate (NSC) examination would pass, b) they had to be within 60km of Stellenbosch, c) they had to offer Mathematics, Physical Sciences and Life Sciences, and d) they had to serve communities who were previously disadvantaged. Ten schools were selected by the WCED based on these criterion. These ten schools were then contacted to set up discussions between the school management, affected teachers and a selection panel from the service provider. Based on these initial discussions the five schools who indicated that they wanted to be part of this project were selected. This according to Given (2008) would be an example of convenience sampling because the most eligible cases were chosen.

The convenience sampling of the five schools that were selected by the panel was based on the following:

#### **a. Geographical location.**

Three different districts in the Western Cape were chosen based on their proximity to the service provider. The primary reason for this was that the closer the service

provider was to the schools the lower the travelling costs would be as well as the time spent travelling between the schools would be minimized. This would have important budgetary implications if the distances to be travelled were too great. The frequency of site visits would decrease with an increase in the distance to be travelled to and from schools.

#### **b. Sufficient buy-in by school staff and principal**

The school staff and the principal of the school had to prove to a panel that they would support and embrace the project. The panel made this judgement based on interviews with the management of the schools and the affected staff. If it was shown that there was enthusiasm for the project once the offering was made clear to them then the school would have been considered.

#### **c. Previously disadvantaged**

The school would have to serve a community who had been previously disadvantaged. The main outcome was to try and uplift disadvantaged learners and communities through this project by giving their learners a chair to stand on as advocated by (Gates & Jorgensen, 2009).

#### **d. Willingness**

The school would have had to show the panel that they needed the help and support offered in the project and that the school would be willing to support teachers and learners in the project activities.

### **3.2.2 Context of the Study**

The SMILES project sought to enhance the level of teaching of teachers in five secondary schools in the Western Cape with the ultimate aim of improving the quality of the education that the learners receive. The five schools were all within 40km of Stellenbosch and all served communities from previously disadvantaged areas.

The subjects that were targeted by the SMILES project were Mathematics, Life Sciences, Physical Sciences and Natural Sciences. These were the subjects that the

Institute of Mathematics and Science Teaching at the University of Stellenbosch specialised in.

**a. Year 1**

During the first year of the project the main emphasis was placed on ascertaining the needs of the teachers and the schools in the project. As was stated in paragraph 2.2 in the constructivist teaching model learners', or in this case, the teachers' prior knowledge or ideas are considered and noted. Their ideas and input were valuable because they gave the necessary platform on which the facilitator needed to build the professional learning opportunity. In paragraph 2.5.1 it was stated that PCK changes and morphs according to the needs of the group being addressed. I was therefore imperative to understand the needs of the teachers in the SMILES project.

All the schools' management teams and the staff who taught the subjects addressed by the SMILES project were invited to a cluster meeting. At this cluster meeting the IMSTUS facilitators had the opportunity to network and introduce themselves to the schools during an informal session after school in the afternoon. As was shown in chapter 2, Fullan and Knight (2011) reported that successful coaches spent a great deal of time with teachers. Facilitators in the SMILES project had to become an integral part of the school and be totally accepted by the teachers who were being helped. Facilitators therefore needed to have a strong relationship with their teachers.

A more formal introduction to all the parties involved then followed with an information session of how IMSTUS saw the way that the project would take shape in the first year. The teachers and management teams of each school then formed groups to pin down their needs. Facilitators could build the intervention based on these needs in accordance with constructivist principles as was discussed in paragraph 2.2. These group sessions were facilitated by IMSTUS and all the different ideas were captured by the facilitators. Each set of needs was then discussed in the wider group and from the complete list the model of the intervention took its first shape.

One of the needs as expressed by one of the schools was that, due to the low socio-economic status of the communities which most of the schools served, the learners seldom had scientific calculators. This was not foreseen when drawing up the budget

but fortunately funds could be reallocated and calculators were then made available to the learners of the five secondary schools at less than half of the market price.

In this year it was imperative that sound relationships between the facilitators of IMSTUS and the teachers in the schools were developed. The initial idea was to have residential workshops over a period of 10 days. This proved to be impractical and several shorter workshops were held instead which amounted to well over 160 hours as Supovitz and Turner (2000) found that there were significant changes in teaching practice after eighty hours of professional development while changing the classroom culture took at least 160 hours. The timing of these workshops proved to be critical as the project did not want the teachers to perceive the intervention as an extra load, but rather as a means to lightening the load. The first workshops took place during school hours. This was for many teachers a chance to take a deep breath and to retreat and recharge. It was planned that the workshops would take place during June as this was when all of the schools were scheduled to write exams. This meant that the teachers that were left at the school would be able to continue with invigilation work in the absence of the SMILES teachers who were at their various workshops.

The physical sciences workshops took place over a period of four days and three nights. The goal was to provide learning opportunities for the teachers for a minimum of 60 hours during the year using cluster meetings and workshops. Classroom visits were to be at least five per school in each of the subject areas. The hours spent during the classroom visits were included in the sixty hours mentioned above. Co-teaching and demonstration lessons were included in the classroom visits. Essentially the idea was to expose the teachers to pedagogical content knowledge at workshops and then to follow this up with school visits where the facilitator would help to implement the ideas that were taught at the workshops.

The content that the teachers would be covering with their learners had to be dealt with in workshops. If this happened before the teacher attempted to teach it to their learners, the chances of them using it and applying it was that much greater than if the workshop was held after the event. The timing of these workshops therefore proved to be critical. Teachers were bound to a work schedule given by the education

department in order that they could finish the curriculum and it was this work schedule that informed project management and facilitators when workshops covering particular content should be delivered. One of the core features of effective professional development is coherence with the policies of the education department (Desimone, 2009). The work that was covered was more likely to be topical, relevant and useful to teachers merely because it was in accordance with the prescribed schedule.

## **b. Year 2**

During the 2<sup>nd</sup> year of the project the WCED (Western Cape Education Department) had decided that the contact time those teachers had with their learners was sacrosanct and could not be tampered with. This created a special challenge for the project as many teachers welcomed the workshops provided by SMILES during school hours as it gave them a different working scenario and a chance to reflect, think and be stimulated to teach in a different way. Time away from the classroom to reflect and grow was welcomed. Maynard and Furlong (1995) implied that the reflective practitioner is what professional development of novices hopes to achieve Schön (1983, 1987) advocated that when teachers begin to reflect-on-action and reflect-in-action then they begin to develop the tools to inform themselves and improve their work in a sustained and reflective way. When teachers attended workshops during school hours it gave them the space to reflect and it did not infringe on their own private time. According to the WCED this had to change and if teachers were going to be out of their classrooms it could only happen after school hours. This was applied to principals as well.

In order to accommodate the new restrictions placed on the timing of our workshops the SMILES project made funds available to schools to source and remunerate substitute teachers in order that the teachers in the project could still be available to attend the learning opportunities offered. Some schools immediately approached different universities and made the positions available to student teachers. In other schools, that did not have such close ties with a university, a parent was often used as the substitute for the teacher attending the workshop. This was not ideal as substitutes were not always qualified to teach the particular subject and teachers found that their work with their learners had to be redone or extensively revised. Ndlovu (2011) writes

that all learners are equally entitled to good teachers, irrespective of socio-economic disadvantage, race, gender or creed. We could therefore not continue with this arrangement.

After extensive consideration and consultation with the affected teachers it was decided that the best alternative was to have workshops that started on the Friday afternoon and went on into the night, resuming again on the Saturday morning and finishing up just after lunch with a cluster meeting. In this way cluster meetings were incorporated into the workshops. In order to provide fifty hours of contact time at least four workshops of this nature had to take place. Fifty hours of contact time would not be enough according to Supovitz and Turner (2000) to affect teaching practice or classroom culture but seeing as we had another three years to run the project delivering fifty hours per year it was more than enough time. It would amount to a total of 150 hours for the rest of the project and sixty hours were already done in the first year. This would be in excess of the 160 hours suggested by Supovitz and Turner (2000).

This was the first time that the project had intruded into the free time of the teachers but when the reasons for the change were made clear to all they agreed that it was the best option. The advantage to the teachers was that they did not have to set extra revision work for the substitutes to do with their classes. Added to this they did not have to review work that a substitute may have (not) handled. In essence they were now taking more responsibility for their classes. As Postle et al (2002) assert , collective responsibility for professional development lies with both the service provider and the teachers or recipients of the service. Initially it was thought that the attendance would drop and that the workshops would be poorly attended, but this was not the case. Finding venues for our workshops became a huge challenge as the normal places that had been used were usually fully booked on weekends many months in advance. Thankfully venues were found that were within our budget.

### **c. Year 3**

Feedback received at workshops and during school visits was that some of what was done in the workshop could not be done in the classroom as the classes were too large

and that the learners were not capable of doing the types of activities and practical work that were proposed. The facilitators felt that this issue needed to be addressed and proposed that they provide extra lessons or practical sessions for the learners in the afternoons with the teachers of those learners present. In Physical Sciences this often took the form of practical sessions as this was the most neglected form of teaching. This was not a unique situation as the same situation was found by Makgato (2007) in Soshanguve, South Africa. Through these extra lessons learners and teachers were exposed to practical work and more specifically how to do practical sessions with large classes.

One of the logistical issues was that the school day became very long for the learners especially if they had not had sufficient food to eat during the day. The energy levels were particularly low at the beginning of the practical sessions. A light snack was provided at the beginning of the session to alleviate this physiological problem (Taras, 2005).

#### **d. Year 4**

In the final year of the project the focus shifted to getting teachers to a point where they did not need the facilitators or the project. The network of teachers in the SMILES project had to be strong enough so that a community of practice would develop. Wenger (1998) defines a community of practice along three dimensions: a) what it is about, b) how it functions and c) the shared repertoire of communal resources. It is this sharing of communal resources which the SMILES project wanted to engender. McCluskey, Sim and Johnson (2011) contend that teachers can develop professionally through improving their techniques, strategies, and knowledge of teaching and their students, either formally or informally, such as through a community of practice. This community of practice would hopefully fill the gap that the facilitators had left. Teachers could not logistically offer in class support and therefore other methods of support were put in place for them to use. The teachers that would interact with each other through phone calls, short message services, email, and shared documents in shared spaces such as dropbox or google docs. These interactions were mainly used to share content such as worksheets, classroom activities and assessment tools.

The fourth year also saw the advent of joint workshops where Mathematics, Life Sciences and Physical Sciences teachers all joined at one venue at the same time for generic workshops. The first workshop dealt with time management, stress management and conflict management. This workshop gave teachers an opportunity to network further with other schools and other teachers who did not teach the same subject. This was necessary as many of the teachers are not just involved with the subjects they teach, but they also work on management teams, run different cultural activities and coach or manage sport teams.

The second workshop concentrated on cognitive skills and how teachers could best stimulate the learners that they were trying to teach. Teachers were also given a chance to experience problem based learning by working through a problem in the same way that learners would do if the teacher used the method. As was said in chapter 2, a key feature of a constructivist classroom is that students are given frequent opportunities to engage in complex, meaningful, problem-based activities Windschitl (2002).

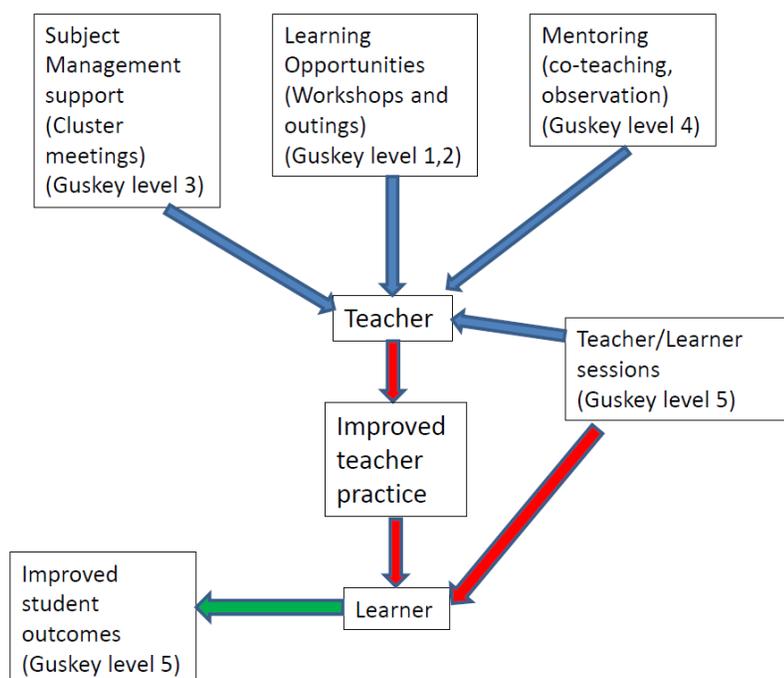


Figure 3.2: Logic Model of SMILES Project

Figure 3.1 indicates the inputs that the activities of the SMILES project and which of Guskey's 5 evaluation levels of professional development they are. The blue arrows indicate support given to teachers in the form of professional development that includes all of Desimone's (2009) core features which may lead to a change in the teacher's attitude or belief. This in turn will result in the improved teaching practice. The red arrows indicate support given to learners by the facilitators and their teachers which hopefully will translate into the green arrow which represents the final intended outcome of the project.

### **3.3 Research Instruments**

Workshop evaluation forms, structured interviews and surveys were used to evaluate the SMILES project. The use of these questionnaires in the project is described in detail below.

#### **3.3.1 Teacher Development Workshops Evaluation Questionnaire?**

The research question that this questionnaire attempted to answer was: What were the perceptions of the teachers regarding the impact of the intervention? Workshop evaluation surveys with a Likert scale ranging from strongly agree to strongly disagree were used immediately after each workshop. These were self-administered questionnaires which were handed in as teachers left the workshop venue. Surveys were used because they could be administered quickly to a large group of people (Creswell, 2009). The need to get the survey done as quickly as possible was because teachers would want to get back to their private lives after a workshop. Open ended questions to illicit in-depth reflective answers would not have worked in the short time available. The surveys were used because we needed to gauge the perceptions of the participants regarding the professional learning opportunity. These surveys link to Guskey's (2000) first level of professional development evaluation.

Evaluation of each training session by the teachers afforded the facilitators and project managers valuable feedback which helped shape the project. It also served as valuable guidance for use in other projects of this nature. At the conclusion of each workshop the teachers were given an evaluation form to fill in. The fact that the surveys were anonymous meant that the respondents could say exactly what they felt without any risk attached. Their responses would not be traced back to them. The information gleaned from the evaluation forms was not regarded as confidential as this information had to be shared with others in order to rectify or improve the offering.

This evaluation was done by means of a survey using statements applicable to the training. These statements were evaluated by the teachers and then they would tick off on a Likert scale ranging from strongly agree to strongly disagree. Teachers were also given a space to write down any general comments that they may have had regarding the workshop.

The questionnaire used was divided into three sections namely, the material presented, the presentation of the material and how teachers perceived their personal growth or benefit from the workshop. (see Addendum A)

Both English and Afrikaans were the languages used in the instrument for three reasons. Firstly, the Matriculation examinations for Physical Sciences were available in English and Afrikaans. This implied that any teachers teaching Physical Sciences had to be fluent in either English or Afrikaans in order to prepare their learners for the final examinations. Secondly, the workshops were presented in English and if there were questions asked in Afrikaans these would be answered in Afrikaans and then translated into English. This was done so that those who could not understand Afrikaans would not be excluded in the discussions. English was chosen as the primary language of instruction because there were more teachers who could understand English than Afrikaans. Thirdly, if teachers could have a choice between the two languages there would be a better chance of getting their true responses as they could choose their language and would not have to struggle to translate the questions /statements as well as give the response. Babbie and Mouton (2001) make it clear that

in a multi-lingual country like South Africa that it is important to translate the instrument into the language of the respondents.

Mertens (2005); Babbie and Mouton (2001); Gay, Mills, & Airasian (2006) and Creswell (2009) all advise against using negative wording and in this instance all the statements were stated positively.

At the end of the second year a project questionnaire was distributed. All teachers and management teams, who were part of the project, were asked to complete it. Fourteen statements were made with which teachers had to agree or disagree on a Likert scale. The statements focussed on fourteen different characteristics of effective professional development which was developed looking at literature pertaining to effective professional development. All five levels of Guskey's (2000) professional development evaluation were assessed in this way.

A survey was chosen because there was a large number of participants who had to give feedback, time was limited and the budget would not allow for individual interviews.

Again all the statements were stated positively as can be seen on the form in Addendum B.

### **3.3.2 Annual overall project evaluation by means of structured interviews.**

What were the perceptions of the School Management Teams (SMTs) regarding the impact of the intervention, was the research question that was answered through these interviews.

At the end of the first second and third years the management teams from each school were invited to a cluster meeting where they would be given the opportunity to give feedback during interviews with facilitators or the project manager. The questions asked were based on a SWOT (strengths, weaknesses, opportunities and threats) analysis regarding the project. The meeting that was recorded for this study was between the project manager and the principals at the end of the project's third year. The interview was recorded and then later transcribed. The advantage of using a

structured interview with open ended questions is that in-depth answers are possible (Mertens (2005); Babbie and Mouton (2001); Gay, Mills, & Airasian (2006) and Creswell (2009)). The participant is given enough time to think and answer the question as fully as possible. Elaboration is encouraged which leads to a deeper understanding of the participants' answers. At the third level of professional development evaluation, (Guskey, 2000) the degree to which the participants are supported by the school or district in which they work is measured. Interviews with school management teams inform this level which is one of the reasons why this method was chosen.

### **3.3.3 Evaluation of teacher/learner sessions by learners**

The research question that we would like to answer here is what were the perceptions of the learners regarding the impact of the intervention?

Mid-way through the project, teacher/learner sessions began in the afternoons. Facilitators would give extra lessons to learners selected by the school in each subject offered. The teachers of those learners were also expected to attend these extra classes but this attendance was mostly threatened by other extra-curricular activities taking place at the school. At the end of the project the learners who attended these teacher/learner sessions were given a questionnaire to fill in with statements regarding the teacher/learner sessions on a Likert scale. Open ended questions were also included in the questionnaire.

After the questionnaire was completed by the learners, focus group interviews were held in which the interviewer asked the same open ended questions to the learners that were posed in the questionnaire. In-depth reflection was required in order to capture the learners' perceptions of the highest level on Guskey's (2000) professional development evaluation hierarchy. During this time learners could explain and elaborate more on their responses made in the questionnaire. This was valuable because a better understanding could be achieved by having the two different forms of data collection. Some learners preferred to write down their responses and others preferred to respond orally to the questions. The instrument was made available in both English and Afrikaans and the interviewer also posed the questions in both languages when needed. The instrument that we used can be found in addendum C.

The responses to the open ended questions were then transcribed if they were verbal or they were typed if they were handwritten.

Word clouds for each of the question were then generated. A word cloud is a graphical representation of the relative frequencies of each word in a selection of text. The size of the word that is graphically portrayed is an indication of its frequency in the text. The larger the word in the word cloud the more often that word appears in the selected text. Conjunctions and other words that appear frequently in text are automatically excluded, but the verbs and nouns which give the essence of the meaning of the sentence are included. A software programme written by Jason Davies (2014) was used for this purpose. This programme was chosen above “Wordle” because the image created does not require extra software to download it as a portable network graphics (“png”) file

McNaught and Lam (2010) highlight some of the limitations of using word clouds as a research tool. Because the frequency of the use of the words in a certain text is used to form the word cloud, this tool is best used for looking at the full text responses from the informants. Any summary by the researcher minimises the usefulness of the word cloud as it becomes the researcher’s words and not the informant’s words. In this case the actual words that the learners used were captured, as they were written, to ensure more reliable results. Another limitation shown by McNaught and Lam(2010) is that all the words are counted and they are presented out of context. By just looking at the word cloud one cannot get back to the original meaning of the text as all the words are out of context. It is for this reason that the word clouds generated in response to the open ended questions will each be discussed. Synonyms or even words that have similar meanings are not treated as one word. This means that if the word “electricity” and “electric” are used, both will be counted and each will be represented in the cloud. The researcher should be aware of these limitations and deal with them accordingly.

### **3.3.4 The Department of Basic Education NSC Examination Results**

Archival data from the Department of Basic Education of the National Senior Certificate examination was collected from 2009 until 2013. The project began in 2009 and came to a close at the end of 2012. The results from 2013 were included because the some of the learners that were involved in teacher/learner sessions wrote their NSC

examinations at the end of 2013. The last cohort of learners from the teacher/learner sessions will write their final exam in 2014.

Year by year analysis of these results for all five project schools in all three subjects were done and are presented in chapter four. These results are then compared with the same results for the province and for the country.

The question that we will attempt to answer is what was the impact of the intervention on learning outcomes, if any?

### **3.3.5 Ethical Considerations**

All data collection in this study was carried out strictly in accordance with the ethical policies of the University of Stellenbosch. See Addendum D for the ethics approval notice. All participants in this research gave their permission for the research to be carried out using their responses to questions posed by the researcher. In the case of minors, permission was received from their legal guardians and themselves.

Anonymity of schools, participants, facilitators and all role players in this study was maintained throughout the study as was prescribed by the WCED Addendum E). Confidentiality is important to protect participants from embarrassment, stress and unwanted publicity (Gay, Mills, & Airasian, 2006) . Participants' responses were not linked back to themselves and as such they remain anonymous and therefore they are protected from risk and unwanted publicity.

## **3.4 SUMMARY**

In this chapter the SMILES project was described in detail and particularly how the project changed over the years. These changes in the project gave rise to different research methods as the needs of the role players changed over the years. MMR and the feature of MMR were discussed. The different research instruments were described in detail and how they were used to evaluate the different aspects of the project. The rationale for choosing the different methods was also highlighted.

In the next chapter, the results gained from the research instruments described above will be presented and an analysis of these results will be made.



## CHAPTER 4

### PRESENTATION AND INTERPRETATION OF RESULTS

#### 4.1 INTRODUCTION

In this chapter the results of the different instruments will be analysed and discussed. This chapter will specifically attempt to answer the following questions as outlined in the first chapter:

What was the impact of the SMILES intervention model on teaching effectiveness?

- a) What were the perceptions of the teachers regarding the impact of the intervention?
- b) What were the perceptions of the School Management Teams (SMTs) regarding the impact of the intervention?
- c) What were the perceptions of the learners regarding the impact of the intervention?
- d) What was the impact of the intervention on learning outcomes, if any?
- e) What other factors were significantly at play during the intervention?

The data collected through survey questionnaires, interviews with the various participants and archival records of the National Senior Certificate results will be presented and analysed in this chapter.

#### **Framework for the analysis of results**

According to Guskey (2000) there are five levels of professional development evaluation information that should be considered as was discussed in the literature review. Each level builds on the one before and they become increasingly more complex.

At the first level the reactions of the participants to the learning opportunity are measured. At the second level of professional development evaluation the participant's learning is evaluated. At the third level of professional development evaluation the degree to which the participants are supported by the school or district in which they work is measured.

The fourth level of professional development evaluation looks at the participant's use of the gained knowledge and skills are examined. At the fifth and final level of professional development evaluation the concern is about student learning outcomes

#### **4.2 PERCEPTIONS OF THE TEACHERS.**

To measure the effectiveness of the SMILES project at Guskey's first level of professional development evaluation the participating teachers were regularly given opportunities to give feedback throughout the project at cluster meetings and after learning sessions and workshops. After a cluster meeting halfway through the project teachers were given a survey questionnaire to fill in using a Likert scale. The questions in the survey all pertained to teaching effectiveness as described by Guskey (2000). The Cronbach Alpha coefficient for the questionnaire consisting of 14 items was 0,85. Cronbach's alpha is an index of reliability associated with the variation accounted for by the true score of the variables being investigated. (Reynoldo & Santos, 1999) This coefficient of 0.85 shows a good level of internal consistency with 1 being perfect. (George & Mallery, 2003) Figure 4.1 summarises teachers' responses question by question.

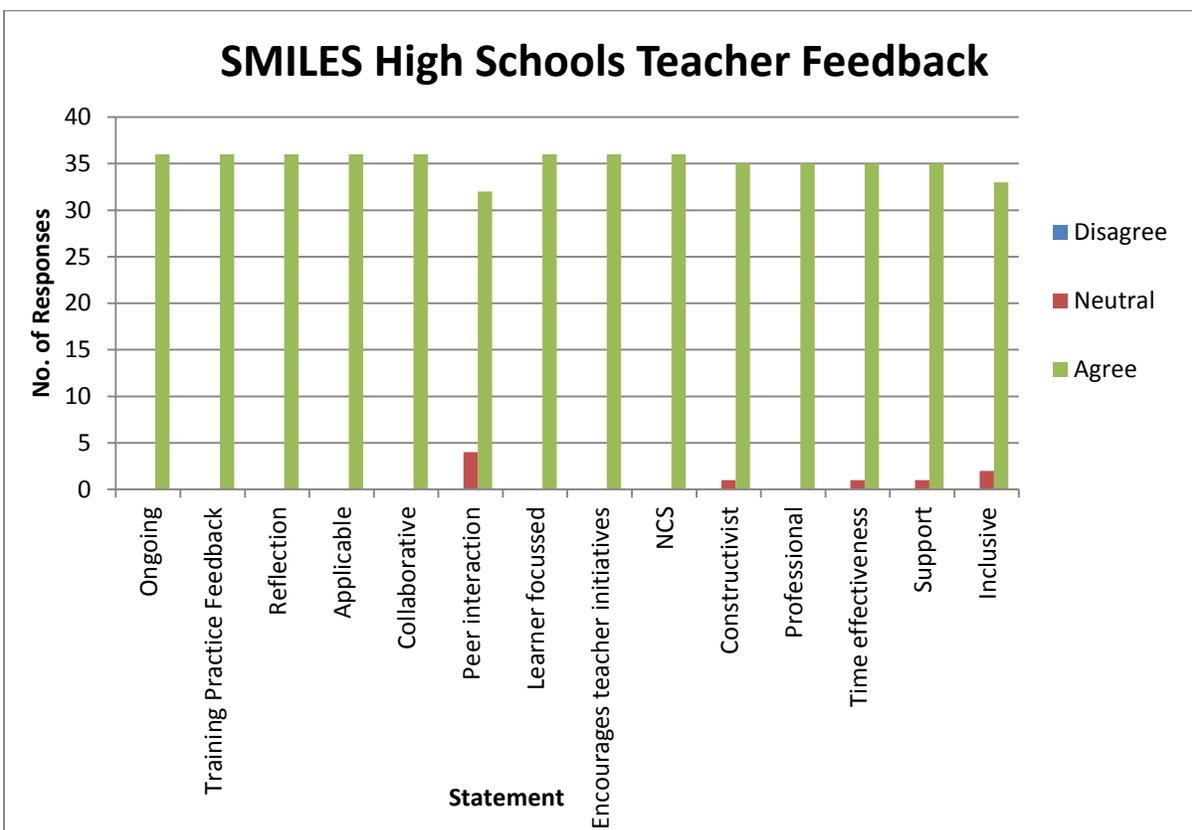


Figure 4.1 Results of the Likert Survey conducted with teachers testing their perceptions of the SMILES project

As can be seen in Figure 4.1 there were no teachers that disagreed with any of the statements that were made in the survey. What is noticeable from Figure 4.1 is that four teachers were neutral regarding the peer interaction statement which read as follows: “SMILES provides opportunities for teachers to interact with peers.” This could imply that these teachers did not interact with peers any more or any less since the beginning of the project. Project management took up this point and, as a consequence, one of the major foci towards the end of the project was to create stronger networks amongst the teachers so that peer interaction could improve.

There were two participants who were neutral regarding the statement: “SMILES training is accessible and inclusive of all in the project schools”. In subsequent general discussions with teachers it came out that although all teachers in the mathematics and sciences subjects were included, the teachers who offered other subjects at their schools were not included. Unfortunately the mandate for the SMILES project was to address Mathematics and the Sciences and not all of the subjects taught at the school.

This could have been the reason for the neutral response but because the questionnaire was completed anonymously these responses could not be followed up.

One teacher was neutral about the statement that said “SMILES training builds on existing knowledge and skills frameworks”. Another teacher was undecided about the time effectiveness of the project and a third teacher was neutral about SMILES providing follow up support after training had taken place. The inability to get reasons for these responses is a limitation of this data collection method. It was not possible to do this because as stated above the questionnaires were filled in anonymously.

If one breaks up the agreeing responses between those who strongly agreed and those who simply agreed, then Figure 4.2 can be drawn up.

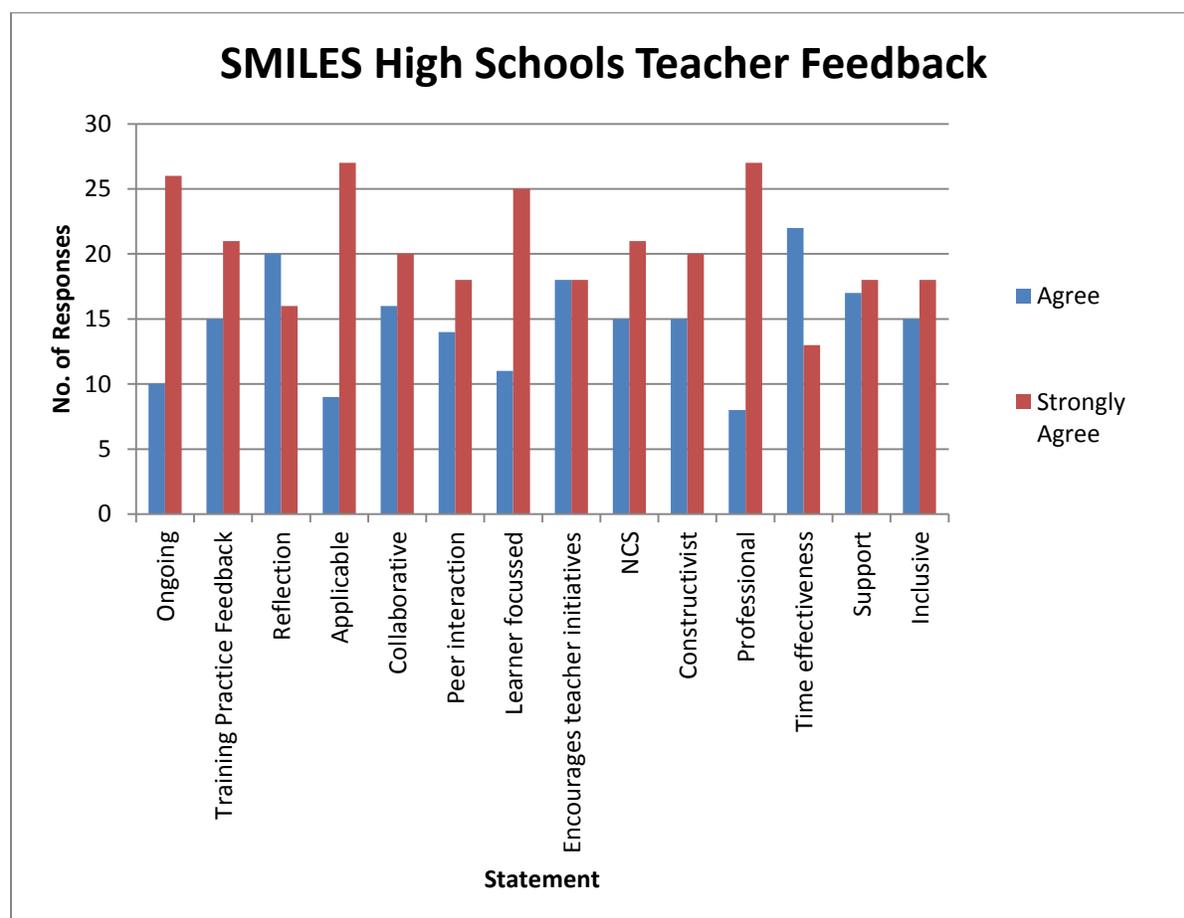


Figure 4.2 Likert Survey done with the teachers comparing the “Agree” responses and the “Disagree” responses.

In all of the statements there were more participants that strongly agreed than those who agreed with the exception of the reflection, time effectiveness and teacher initiative statements.

The reflection statement reads “SMILES has afforded opportunities for individual reflection”. Critical reflection by individuals during training was valued but because fewer respondents strongly agreed with it, it could imply that more opportunities for reflection, as described by Schön (1983, 1987) and discussed in chapter 2 in this study, would have been welcome.

The statement “SMILES training is time effective and provides adequate time to address the content” had less respondents strongly agreeing. Length of time spent on training and judicious use of that time is always a challenge to manage as discussed in paragraph 2.7.1 in chapter 2.

The statement “SMILES encourages and facilitates school-based teacher initiatives” had an equal number of respondents agreeing and strongly agreeing. All teacher initiatives to improve the quality of schooling were highly valued as this showed the project management that a teacher or a school could autonomously continue with the work without the constant prompting of the SMILES project.

Four “Strongly agree” columns stand out in Figure 4.2, namely “Ongoing”, “Applicable”, “Learner Focussed” and “Professional”. Ongoing refers to the project being sustained continuously for a long time (Desimone, Garet, Birman, Porter, & Yoon, 2001). The project ran for a total of four years which would have given teachers enough time to interact with the facilitators and the content had there not been such a large teacher turnover as will be discussed in chapter 5 in paragraph 5.3.5.2 (Smith, T. M., & Ingersoll, R. M., 2004).

Applicable refers to the SMILES project being based in schools and applicable to teacher’s work. This was key as teachers could see the principles and topics that they received training on being applied in their contexts in their schools. The training was brought closer to home by supporting the teachers in their schools.

The SMILES project was focused on educators in order to enhance learner's understanding. This was the outcome on which the project was based. This is in line with Guskey's (2000) fifth level where the performance of the learner is evaluated as a measure of the success of the programme.

"SMILES facilitators treat educators as professionals in their field" was the statement that elicited the greatest number of "Strongly Agree" responses. This suggested the possible existence of high levels of professionalism and conscientiousness among facilitators.

### **4.3 PERCEPTIONS OF SCHOOL MANAGEMENT TEAMS (SMTS)**

Each of the schools principals was interviewed and audio recordings were made of the interviews. These interviews were transcribed and key findings that emerged are discussed below. A code is inserted after each of the principal's remarks in order that it can be referenced when discussing it in this study. An example would be [SP1R2] which refers to School Principal 1 Remark 2.

#### **4.3.1 School 1 Principal's comments regarding the SMILES project**

The principal of school 1 made the following remarks regarding the intervention at his school:

- *"SMILES is going excellently well. Teachers show great enthusiasm for the project and the teamwork amongst the teachers is very good, more so than before, much better than before. I get a lot of feedback from the teachers and I am kept abreast. [SP1R1]*
- *Teachers are used to facilitators coming into their class and there is no negativity around that. [SP1R2]*
- *The project needs to help us identify learners with potential to take science and then nurture them. We also need to address the language issue with our learners. Some of the learners have a big language barrier. [SP1R3]*
- *I am very impressed especially with the communication side. Excellent! The consultative process is key to the success of this project, the interaction is good. [SP1R4]*

- *Our participation in the SMILES project played a major role in producing quality results in Mathematics and Physical Sciences. Our educators (Maths, Life Science, Physics) are better equipped and confident to teach these subjects. We gained a lot of experience, expertise and resources relevant to the teaching and learning of these subjects.” [SP1R5]*

#### **4.3.2 School 2 Principal’s comments regarding the SMILES project**

The school management team school 2 made the following remarks about the SMILES project:

- *“No I think it’s wonderful actually in fact it has more than met my expectations because, especially the staff development side of it. That is what impressed me. I could see that the teachers were meeting regularly. They took them on weekends for their development. And I firmly believe that you can only deliver as much as you have. When we had whole school evaluation last year, the main problem that was identified was that the lessons did not afford enough opportunities for learners to read and to discuss, which is all about teacher skills. [SP2R1]*
- *With the new curriculum, I find that SMILES, listening to the teachers and what they are saying, you can see that they are enjoying it and learning a lot. I also appreciate the opportunity that you gave to the whole staff to attend the session on learning styles. [SP2R2]*
- *Our learners cannot afford extra classes so that will be something that the learners need. [SP2R3]*
- *SMILES, I want to work with very closely. I want to work with NGO’s that are effective and that are giving good support. That is why we are working with SMILES and we hope that it will continue for a long time. [SP2R4]*
- *The teachers don’t want me in their class but they want the SMILES facilitators because they are supporting them and not inspecting them.” [SP2R5]*

### 4.3.3 School 3 Management Team's comments regarding the SMILES project

The interview with this principal was cut very short by a more urgent matter which is why the response was so limited. The principal of school 3 made the following remarks on behalf of his school management team:

- *“Very impressed! [SP3R1]*
- *All the facilitators play a big role at the school. Facilitator 1 is a complete star. [SP3R2]*
- *Everyone is doing their bit and all the teachers are involved.” [SP3R3]*

### 4.3.4 School 4 Management Team's comments regarding the SMILES project

The principal of school 4 made the following remarks on behalf of his school management team:

- *First of all, thank you for the opportunity of being part of this project. [SP4R1]*
- *The year didn't start so well with the one teacher that did not want to be part of the project. If I talk to all the other people then they are very positive especially after June when they had that week long workshop. They came back all excited, they said now they know what it's about and what they must do. [SP4R2]*
- *They keep me informed about all the activities. One teacher asked if I could take away his cricket coaching so that he could concentrate on Science. [SP4R3]*
- *The other positive thing is facilitator 1, the manner in which she comes into the class and says come let's work on this or that, they are very impressed with her. We do our planning with her and she has good ideas. She is going to do all the planning with the teachers. We thank SMILES for making a difference and we thank you and the facilitators at our parents evening. [SP4R4]*

### 4.3.5 School 5 Management Team's comments regarding the SMILES project

The principal of school 3 made the following remarks on behalf of his school management team:

- *“I had a chat with teacher 1, and regularly talk to teacher 2 and teacher 3 about the project. I am highly impressed with the programme. [SP5R1]*
- *Facilitator 1 came in and she is (seen as) part of the staff and she is of great help. She had a meeting with all the maths staff and it was all positives that came out. I am highly impressed. She is always here to help, always looking in. She is a great help for the maths teachers and she is part of our team. [SP5R2]*
- *Teacher 2 said that facilitator 2 came and helped her with the practical side of science. She said that’s what she needs and if the project can focus on what our needs are, it will work wonders. [SP5R3]*
- *I have only positive things to say about the programme. They are accepting the facilitators into their classes much easier than I thought – the facilitators are part of the staff.” [SP5R4]*

#### **4.3.6 Discussion of trends emerging from the interviews with Principals of each of the schools**

From the above it can be seen that one main theme that came out was the acceptance of the SMILES facilitators in the classrooms (e.g. [SP1R1], [SP5R4]), the learning opportunities that the teachers received and the need for work to be done with learners in the schools. By focussing on the teachers in order to enhance learner performance and then working with learners places the professional development level of this intervention on Guskey’s fifth level.

##### **4.3.6.1 Facilitation**

It can be seen that the facilitators were accepted into the classrooms as members of the staff of the various schools. The principal from school 5 said specifically that “the facilitators are part of the staff” [SP5R4]. One of the concerns raised by the facilitators at the beginning of the project was that they may not be welcomed into the classrooms of the teachers because it would be seen as intruding into the teacher’s domain and space. This was proved to be unfounded by the remarks of the principals as the facilitators were welcomed as peers and not as people of higher authority doing inspection. Level four of Guskey’s (2000) professional development hierarchy is the level where one will ascertain whether the material shared with the participants is being used for its intended purposes or not. This is precisely what was being done in the

SMILES project by the facilitators as mentioned by the principal above [SP1R5]. Facilitators were present in the classes doing direct observation (e.g. [SP5R3, SP5R4, SP4R4, SP1R2], helping with lesson plans [SP5R2, SP4R4] and reflecting with the teachers what could be changed or done differently to ensure that learning takes place [SP5R2, SP4R4].

One principal noted that teachers in his school didn't want him in their classrooms, but they welcomed the SMILES facilitators because they were there to support the teachers and not to inspect [SP2R5]. Biputh and McKenna (2010) show that the teachers who used to teach in South Africa during the apartheid era viewed inspections from subject advisors with a great deal of suspicion and distrust. Negative forms of appraisal dominated to the extent that teachers and schools reacted violently to the authorities' reports (Biputh & McKenna, 2010). The reluctance of teachers having someone else in their class could stem from this. Teachers do sit in on each other's classes to observe lessons for quality management as prescribed by the Department of Basic Education (2004).

It is important to note that the support that teachers were given by facilitators had to involve elements of appraisal, constructive criticism, detailed observation, analysis and modelling of lesson presentations. In order to support the teacher the facilitators had to have a complete idea of what the teachers were doing in their classes. The fact that teachers saw the classroom visits as "support" was very positive and showed that the facilitators could criticize constructively. Facilitators would have had to look very carefully at the classroom situation during lesson observations in order to be factual in their appraisal and have it interpreted as support and not just summative evaluation.

From the comments above it can also be seen that facilitators were not only involved in the classroom during lessons but also had follow up meetings with the entire subject staff [SP5R2, SP4R4]. At these meetings subject planning took place which would have involved a thorough knowledge of what went on in the classroom [supply code]. The type of learners involved, the conditions and resources at the teachers' disposal would all have to be taken into account before one could make a meaningful contribution at a subject meeting. The advantage that facilitators had over the rest of the staff was that they had seen all the subject teachers teaching in their classrooms.

This afforded them an overall view of the subject as it was being delivered in the school which meant that they could use the strengths of each of the teachers to help with the planning. To have the facilitators involved in the planning sessions made perfect sense as the facilitators could bring in an objective view which none of the teachers could do.

#### **4.3.6.2 Learning opportunities for teachers**

Learning opportunities for teachers were received very well and many of the principals commented that the teachers who were part of the programme came back enthused and more equipped [SP1R1, SP1R5, SP2R1, SP3R3, SP4R2]. Changing the attitudes and beliefs and enhancing the knowledge of the teachers was achieved here which relates to levels one and two in Guskey's five levels of professional development. One of the principals stated "They came back all excited, they said now they know what it's about and what they must do." [SP4R2]. This implied that prior to the workshop, the teachers were not clear as to what they could gain from the SMILES project or in fact whether they needed it. Now they understood that we wanted to expose them to a different way of teaching, one that would require critical thinking and the application of pedagogical content knowledge and not the more traditional methods that are still used today.

The principal from school 4 said that the first year of the project did not start well in response to the fact that one of the teachers did not want to be part of the project. This particular teacher did not feel that there was anything else to learn in the subject that he offered. This teacher was also the subject head which meant that all the teachers reporting to him felt betwixt and between as they wanted to be a part of the project. This issue was straightened out by having a very open discussion about the project and its expectations with all concerned parties. The voluntary nature of the project was reiterated and the teachers could choose whether they would be part of the project or not. The outcome was positive and all the teachers remained in the project with the one exception. Desimone (2009) comments that professional development is usually done more effectively with teachers who volunteer for it, are motivated and are keen to try something new. She goes on to say that the most qualified teachers are the ones who seek out professional development that contains the core features of effective professional development as discussed in chapter 2.

#### **4.3.6.3 Principals' awareness of the project activities**

It was clear that the principals from all the schools were very aware of the project activities which included, workshops, lesson observations, co-teaching, teacher/learner sessions, school outings and regular subject/cluster meetings[SP1R1, SP2R2, SP4R3, SP5R1]

The involvement in the project by the management in the schools was also clear from their comments as they knew about all of the aspects of the project and what impact it was having upon their staff [SP1R1, SP2R2, SP4R3, SP5R1]. They all knew the names of all the facilitators [SP5R2, SP5R3, SP3R2, SP4R4,]. The facilitators' names have been replaced with facilitator 1 or facilitator 2 etc. in order to protect their anonymity.

#### **4.3.6.4 Improvements to the project**

Principal 3 [SP2R3] highlighted the fact that the learners in his school could not financially afford extra lessons and that was something that the learners would need. Principal 1 suggested that learners with potential should be identified and nurtured [SP1R3]. This feedback resulted in extra tuition classes in the afternoons for those learners who showed potential.

Those sessions were dubbed “teacher/learner sessions” because the intention was to have the project facilitators present lessons to learners with their own teachers present. After the lesson the teachers and the facilitator could discuss the pedagogy involved in the lesson. Unfortunately this only materialised in only two of the schools where teachers stayed behind for the afternoon classes. It must be made clear that discussions with all teachers in the project regarding pedagogy occurred after every school visit and classroom visit. It was only during the extra classes in the afternoons that some of the teachers could not remain behind for discussions on pedagogy. In all of the schools the selected learners attended extra classes in Mathematics, Life Sciences and Physical Sciences. Feedback from these learners will be discussed in paragraph 4.4.

## 4.4 LEARNERS PERCEPTIONS

### 4.4.1 Likert Survey

All the learners that were selected for the teacher learner sessions were given a questionnaire to fill in which used a Likert scale. The Cronbach alpha coefficient was 0,51 for the survey which is poor according to George & Mallery (2003). Figure 4.3 shows the results of this survey:

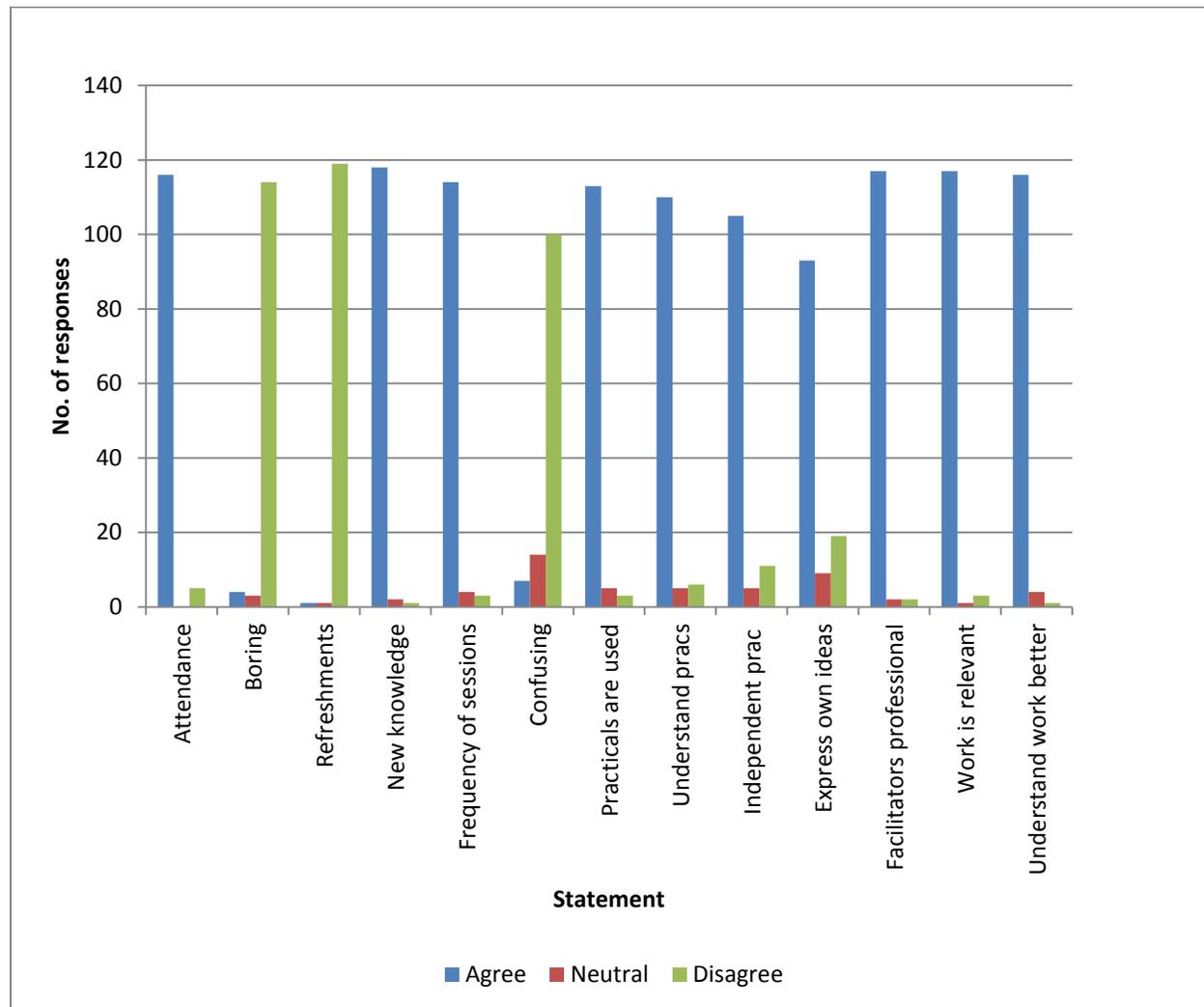


Figure 4.3 Likert survey conducted with Learners testing their perceptions of the teacher/learner sessions.

The key words for each statement used in Figure 4.3 are explained below:

**Attendance** referred to their willingness to attend the teacher/learner sessions.

The next statement was to find out if the sessions were perceived as **boring** or not.

**Refreshments** were provided and it was asked whether this was the reason for attending teacher learner sessions.

**New knowledge** referred to whether they learnt something new in the teacher/learner sessions

**Frequencies of sessions** determined if they wanted to attend more sessions.

**Confusing** referred to whether learners found the sessions confusing or not.

**Practicals are used** determined whether the teacher/learner sessions were presented using practical methods or not.

**Understand practicals** asked whether learners understood the work better if it was done practically.

**Independent practicals** determined whether learners enjoyed doing the practical tasks by themselves

**Express own ideas** referred to time being made to let everyone in the teacher/learner session have a chance to express themselves.

**Facilitators are professional** ascertained whether learners regarded the behaviour of the facilitators as professional.

**Work is relevant** determined whether the work done in teacher/learner sessions was linked to what was done in their normal classes at school.

**Understand work** better was the statement that asked whether the learners understood their work better after a teacher/learner session

As can be seen in Figure 4.3 above, there are three statements that were stated negatively. It is obvious then that if the learner disagrees with the statement then it is a positive response. This reverse scoring was taken into account when the Cronbach Alpha coefficient was calculated.

From Figure 4.3 we can see that the item that scored the lowest number of positive responses was the statement: "I get the chance to express myself during teacher learner sessions". It must be acknowledged that it took many sessions before the learners opened up and were comfortable in asking questions and challenging the facilitator. Once they realised it was encouraged to ask questions and that their opinions mattered the floodgates opened. The interaction was lively and therefore there may have been times when learners did not get equal opportunities to express themselves.

The high scores for “new knowledge” and “understand the work better” show that the teacher/learner sessions were achieving some of the outcomes set for the project. Learning was enhanced through this intervention as was testified by the learners themselves. This was evaluation of professional development effectiveness at level five according to Guskey’s (2000) hierarchy where learners’ knowledge and skills are influence positively.

Looking at the first statement about attendance one notices that the learners tried to attend the sessions. This result did not come as a surprise as their attendance was excellent which speaks volumes about their attitude towards the programme and the subject. Their intention to attend the sessions is an indication that their attitude towards the programme or subject is positive.

The highest number of negative responses came from the statement “Teacher/learner sessions confuse me”. This in itself may not be entirely negative because it would be acceptable if one were confused during the session but ultimately understood. In spite of the confusion that some learners may have had, the last statement where they indicated whether they understood the work or not made the overall result a positive one. Cognisance must however be taken of the fact that some learners felt lost during some of the sessions. This means that facilitators would have needed to take note of this and adjust their lessons accordingly.

#### **4.4.2 Word Clouds**

The following word clouds were generated using software written by Jason Davies (2014).

##### ***4.4.2.1 Most helpful teacher/learner session***

The first open ended question that was posed to the learners was: “Which teacher learner sessions helped you the most?”

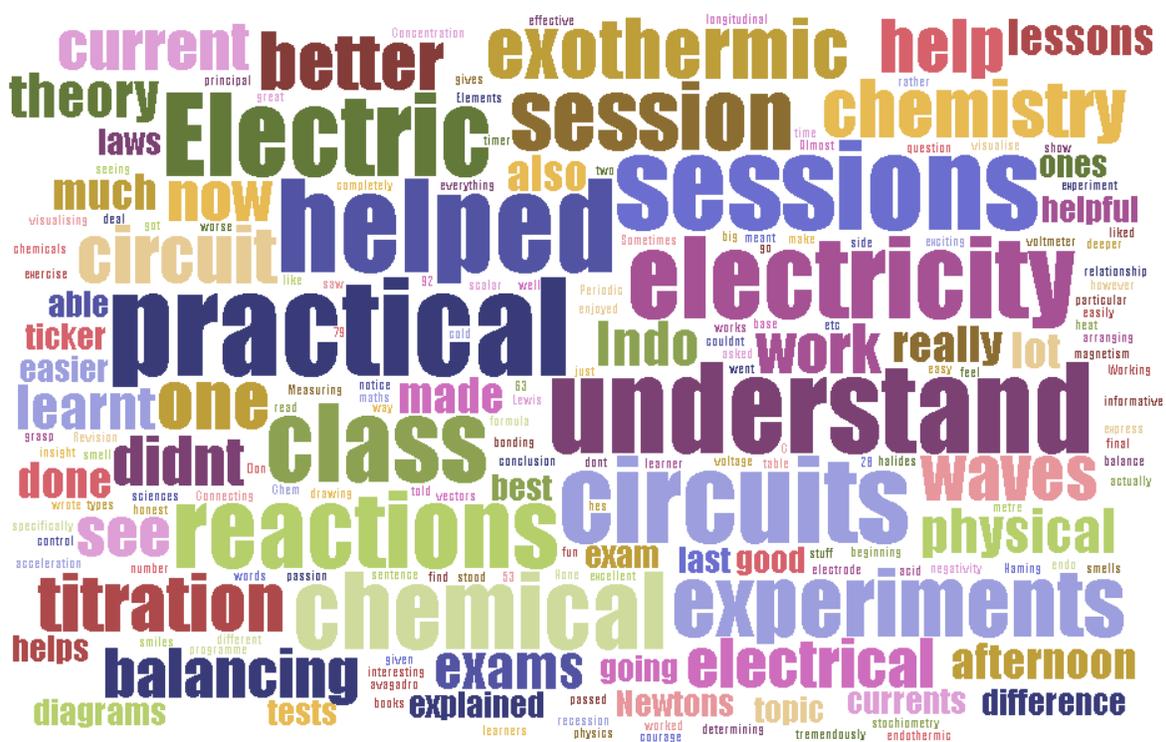


Figure 4.4: Word Cloud generated in response to the question: “Which teacher learner sessions helped you the most?”

From the word cloud in figure 4.4 the sessions that the learners enjoyed most were those in which practical experiments and investigations were carried out. Many different practical sessions were done but the ones which stood out were clearly the sessions that dealt with electrical circuits and chemical reactions. If one looks carefully at the word cloud in figure 4.4 one will notice the words “electricity”, “electric” and “electrical” are all highlighted. If one were to merge these words it would give a clear indication that the practical work done dealing with electricity was the session that the learners enjoyed the most.

Another word that stands out is “chemistry” and “chemical” which indicated that chemistry was also one of the favourite topics in these sessions. An example of what a learner wrote is: “The chemistry practical stuff and chemical reactions, balancing and formulas.”

“Helped”, “understand” and “practical” also gave very positive feedback regarding the teacher/learner sessions as these words came up frequently and indicated that the practical sessions helped the learners to understand the work more clearly.







One of the learners had this to say: “It is a great way to ensure a better understanding of the work because hearing it from a different view helps you understand it better. It helps us ensure a pass at the end of each term and it is very important because not all learners can afford to pay for extra classes.” This ties in with one of the comments [SP2R3] made by principal 2 when he said that the learners in his school could not afford extra classes. Another point this learner made was that a new face presents the work differently which helps to enhance understanding. The learner was making an observation that is at a higher level than most when objectively looking at the project and offering a reason for its success. This requires critical thinking skills which was heartening to see. The learner was not making a judgement on his or her teacher’s pedagogical skills, but merely stating that if the same work is presented in a slightly different way they have greater chance of understanding it.

#### **4.5 SCHOOL BY SCHOOL ANALYSIS OF GRADE 12 NATIONAL SENIOR CERTIFICATE RESULTS**

Umalusi is the Council for quality assurance in General and Further Education Training who is appointed by the Minister of Basic Education to set and monitor standards for general and further education and training in South Africa in accordance with the National Qualifications Framework Act No 67 of 2008 and the General and Further Education and Training Quality Assurance Act No 58 of 2001. The NSC is moderated and controlled by Umalusi who is responsible for establishing reliability and validity of this important assessment structure.

The grade 12 results from all five high schools that were in the project were collected from 2009 to 2013 to determine the effect of the SMILES project on student achievement, if any. Although the project came to an end at the close of 2012, three of the five schools had learners who were part of the teacher/learner sessions wrote their final examinations at the end of 2013. The other two schools will have their learners who were involved in the teacher/learner sessions write their final examinations in 2014.

### 4.5.1 Project school learner achievement in Mathematics

The following graph depicts the results of the five schools in Mathematics for the period from 2009 to 2013.

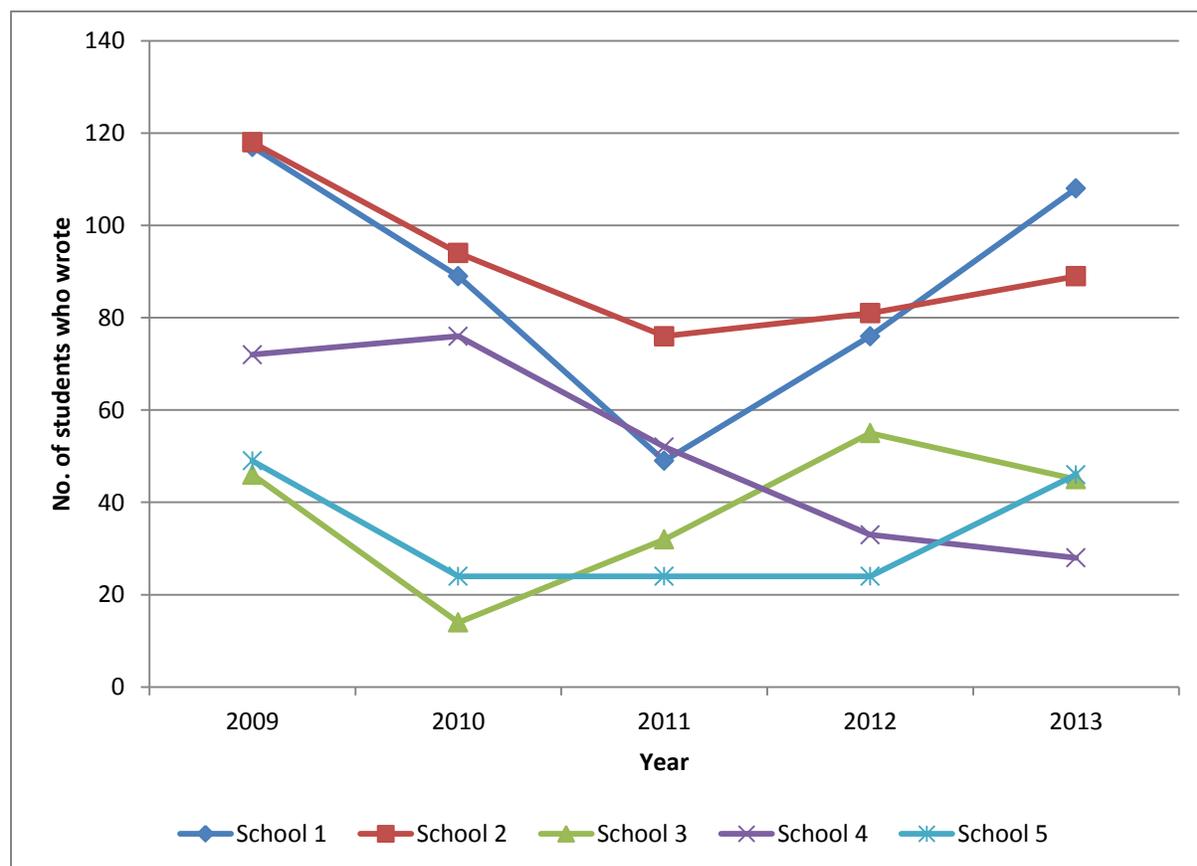


Figure 4.8: Graph of the number of learners who wrote Grade12 NSC Mathematics

From Figure 4.8 the following can be seen:

School 1 had a sharp decline in numbers from 2009 to 2011. They started with 117 learners in 2009 and ended in 2011 with 49. 2011 was the turning point for school 1 and they managed to have 76 in 2012 and 108 in 2013. Hopefully this trend continues.

School 2 also had an overall decline in numbers in the first three years of the project, starting with starting with 118 learners in 2009 and dropping to 76 in 2011. Over the

next two years they increased their numbers taking mathematics to 89, which is positive.

School 3 began the project with 46 learners, dropped down to a meagre 14 in 2011 and then showed an increase for the remainder of the project to 55 learners taking mathematics in 2012. Sadly this dropped to 45 in 2013

School 4 started well in the first two years of the project with 72 and 76 for the two years. Unfortunately this number declined steadily over the next three years to a total of 28 learners offering Mathematics in 2013.

School 5 started with 49 learners taking mathematics which then dropped to 24 for the next three years. In 2013 tis number increased again to 46.

All the schools except for school 4 showed a decrease in numbers from the first year to the second. This could have been due to the extended holiday that schools had whilst the soccer world cup was being played coupled with a public servants strike in the third term. Learners may have decided to opt for the easier mathematical literacy in order to pass the NSC as a whole.

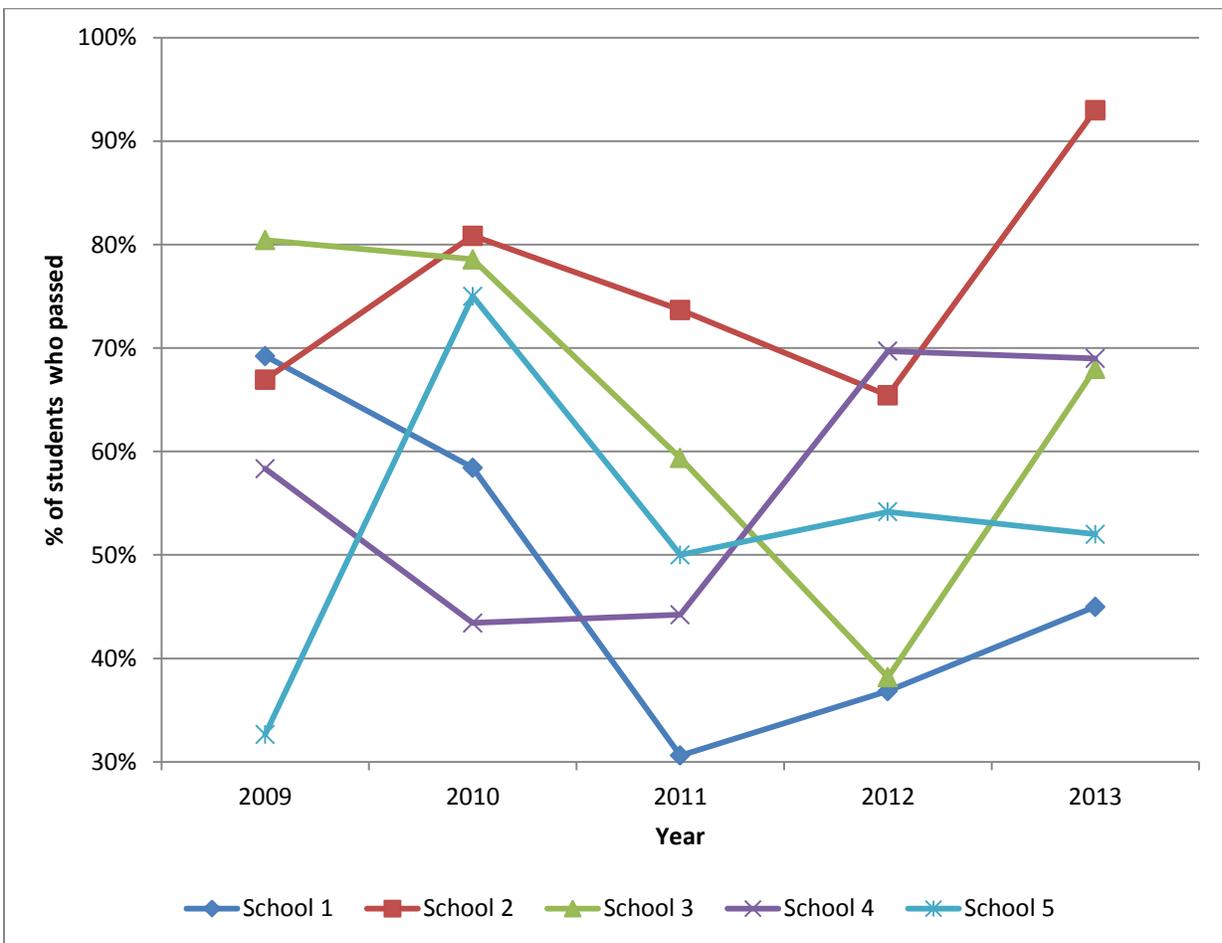


Figure 4.9 Graph of the percentage of learners who passed Grade 12 NSC Mathematics

In Figure 4.9 it can be seen that the percentage of learners that passed in schools 2 and 4 increased over the five years. School 1 and school 3 both had their mathematics subject heads move to other employment at the start of the project. The decline in percentage pass rate in the first two years could have been partly due to these resignations. The overall trend from 2011 to 2013 is an upward one in all of the schools except for school 3 who had a massive decline in 2012. At this the end of 2012 the project teachers had been exposed to all that the facilitators had to offer as far as material was concerned and were beginning to implement this material in their classes. Teachers agreed in their Likert survey that NCS content was covered in the project which also was a factor that could have helped improve the Mathematics results being shown here. Unfortunately this did not result in better student outcomes for 2012, but it could take a bit longer to see the effect in learner's marks. Schools 2 and 3 showed a sharp increase in their results from 2012 to 2013. In school 2 the learners that wrote

these exams were part of the teacher/learner programme, but this was not the case for the learners in school 3. The reason for the sharp increase in schools 2 and 3 cannot be attributed solely to the SMILES project as there were many other factors that could have had an influence on the results. However, the feedback from the learners in their Likert survey and in the word cloud presentations endorse that they had a better understanding of the work in the curriculum. The last statement in the Likert survey with the students indicates that they agreed that they had a better understanding of the work, which triangulates with the results shown here for schools 2 and 3. In the same way the SMILES project cannot be blamed for the sharp decrease in marks for the results from schools 1, 2, 3, and 5 from year 2010 to 2011. It is likely that the SMILES project did contribute positively to the schools as teachers were beginning to change their practice but was not the panacea for all Math ills. Teachers responded in the Likert surveys that the work done was applicable and rooted in the National Curriculum statement. This is typical of the level four described in Guskey's (2000) work on Professional Development evaluation where teachers are applying the material in their classrooms.

#### **4.5.2 Project schools' learner performance in Physical Sciences**

There was also a noticeable overall decline in the number of learners taking Physical Sciences over the 5 years as shown in Figure 4.10. This was coupled with an overall increase in the percentage pass rate for all of the schools as shown in Figure 4.11. The attitudes of the learners that continued to take Physical Sciences were positive towards the subject as can be seen in paragraph 4.4.2. If the attitude of the learners is positive towards the subject then an increase in the pass rate could partly be attributable to the improved attitude of the learners.

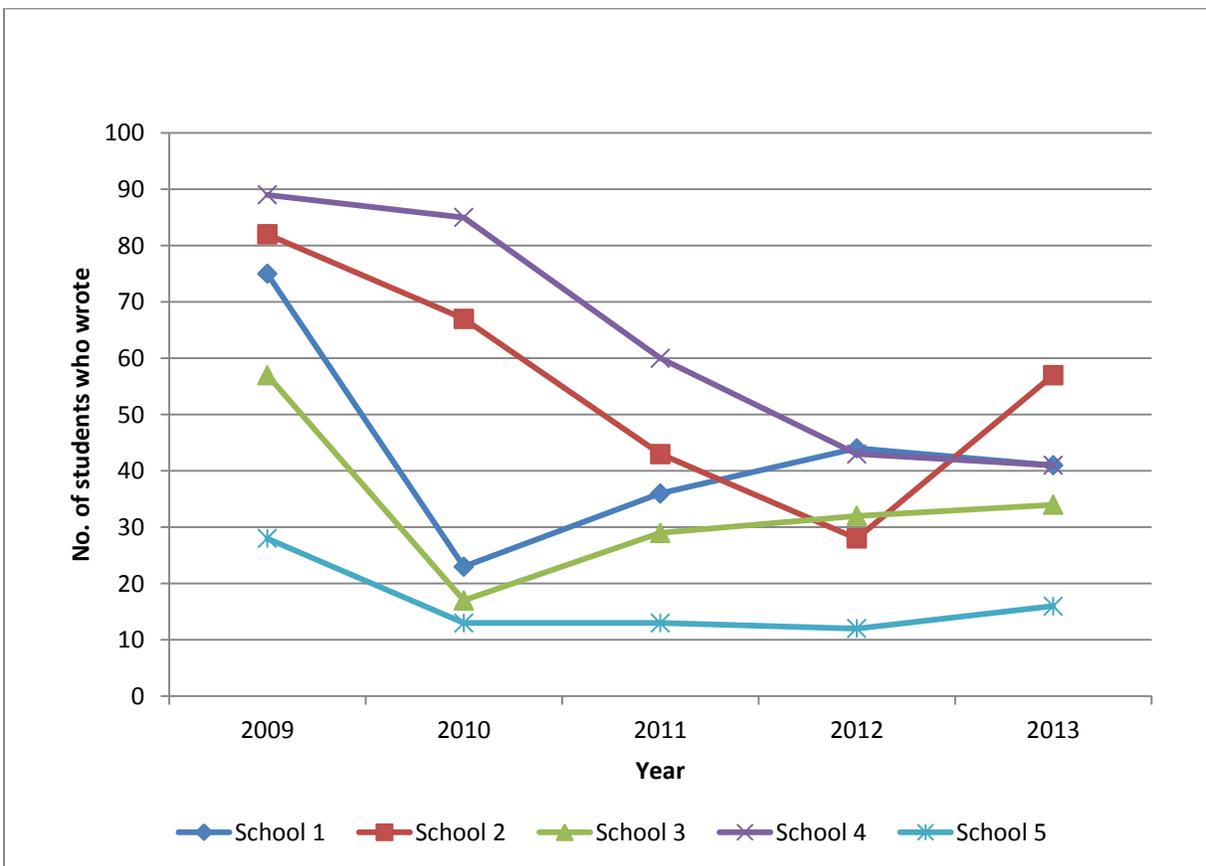


Figure 4.10: Graph of the number of learners who wrote Grade12 NSC Physical Sciences

All the schools showed a decrease in numbers taking physical sciences in the first year of the project. This could have been due to the Soccer World cup and the public servants strike in 2010 as was mentioned above.

School 1 dropped from 75 to 23 in the first year. They then increased to 36 and 44 by the end of the project in 2012. A slight drop in numbers was experienced in 2013 to 41 learners

School 2 dropped steadily from 82 learners in 2009 to 28 in 2012. This number more than doubled to 57 in 2013. The 2013 cohort of learners were all part of the teacher/learner programme from 2011 to 2012 which may have been partly the reason for the increase in number of learners offering Physical Sciences in 2013.

School 3 dropped from 57 learners at the beginning of 2009 to 17 in 2010. After that they increased to 29 in 2011, 32 in 2012 and 34 in 2013. The 2014 cohort will be the group who had teacher/learner sessions.

School 4 had a steady decline of learners taking physical sciences from 89 to 41 over the five years. In the last year the decrease was minimal from 43 to 41 which hopefully will signal an upwards turn in the number of learners doing Physical Sciences. In this school the 2014 cohort had two years of teacher learner sessions in their grade 9 and grade 10 years.

School 5 had the least amount of learners taking physical sciences out of all the project schools throughout the 5 years. In 2009 they had 28 learners which then decreased to 13 in 2010 and 2011. There were only 12 in 2012 which increased to 16 in 2013. The 2013 cohort had the largest input in the form of teacher/learner sessions.

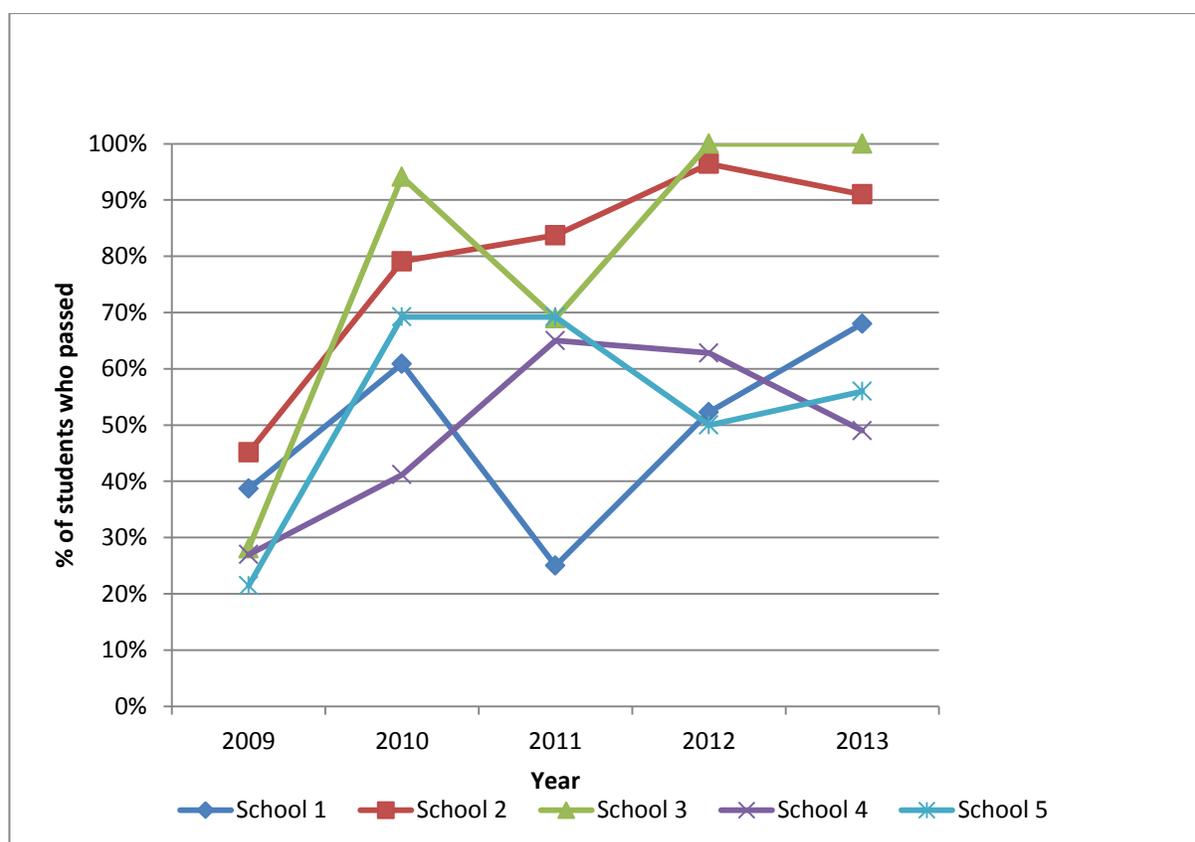


Figure 4.11: Graph of the percentage of learners who passed Grade 12 NSC Physical Sciences

As can be seen in Figure 4.11 schools 2 and 3 are the success stories in that they raised the bar to the point where school 3 had 100 % of their learners passing in 2012 and 2013. School 2 more almost doubled the number of learners taking Physical Sciences from 2012 to 2013 and also managed a very respectable pass rate of 91%. School 1 started with a pass rate of 39 % which they increased to 61% in 2010.

Unfortunately they dropped right down to 25 % in 2011. In 2012 they managed to increase it to 52% and then to 68% in 2013. Hopefully the upward trend will continue.

The Physical Sciences teachers from schools 1, 2, 3, and 4 all attended all training workshops presented by the facilitators in the SMILES project. Teacher 5 did not attend the professional development learning opportunities throughout the project. Teacher 5 argued that the Grade 12 learners needed help more than what he or she needed professional development and thus would not attend the learning opportunities offered by the project. Teacher 5 did welcome us into the classroom and the learners also attended teacher/learner sessions. Therefore the project did have some Physical Sciences input in this school, but not to the same extent as the other schools.

Learners responded very clearly in the survey that they understood their work much better and that they enjoyed practical sessions. This understanding can be seen in the improvement in their results. Teachers also responded that the NCS content was covered in the project which also was a factor that could have helped improve the Physical Sciences results being shown here.

### 4.5.3 Project schools' learner performance in Life Sciences

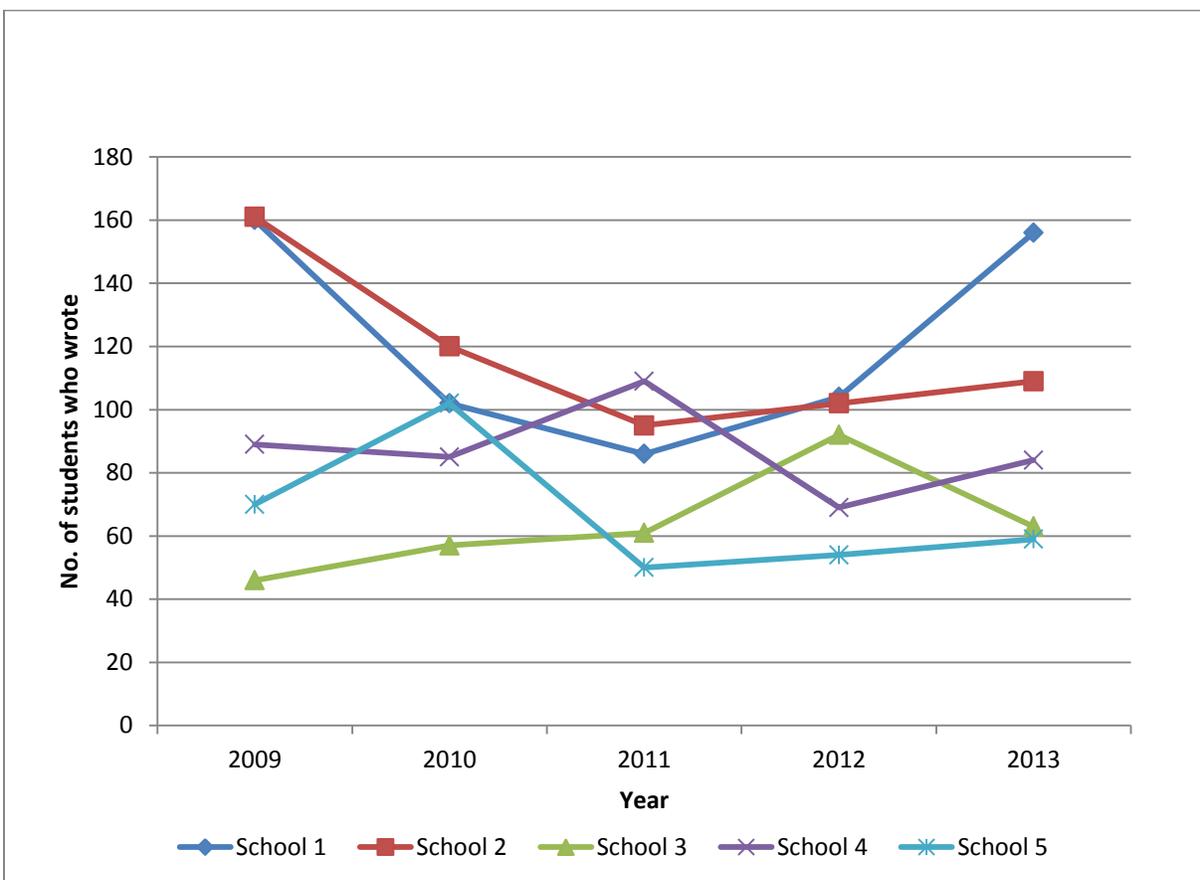


Figure 4.12: Graph of the number of learners who wrote Grade12 NSC Life Sciences  
 In Figure 4.12 it can be seen that school 1 had a decrease from 160 learners taking life sciences in 2009 to 102 in 2010 and then to 86 in 2011. In 2012 this figure increased to 104 and then in 2013 156 learners offered life sciences.

School 2 started with 161 learners in 2009 which then dropped to 120 in 2010 and 95 in 2011. In 2012 the numbers of learners taking Life sciences increased to 102 and still further to 109 in 2013. School 3 increased their numbers throughout the project from 46 in 2009 to 92 in 2012. The next year saw a decrease of 29 learners to a total of 63 offering life sciences. School 4 started with 89 learners in 2009 and then peaked in 2011 with 109. They then dropped to 69 but managed to increase it to 89 in 2013.

School 5 started with 70, peaked in 2010 with 102 and then dropped down to the 50's for the next three years ending with 59.

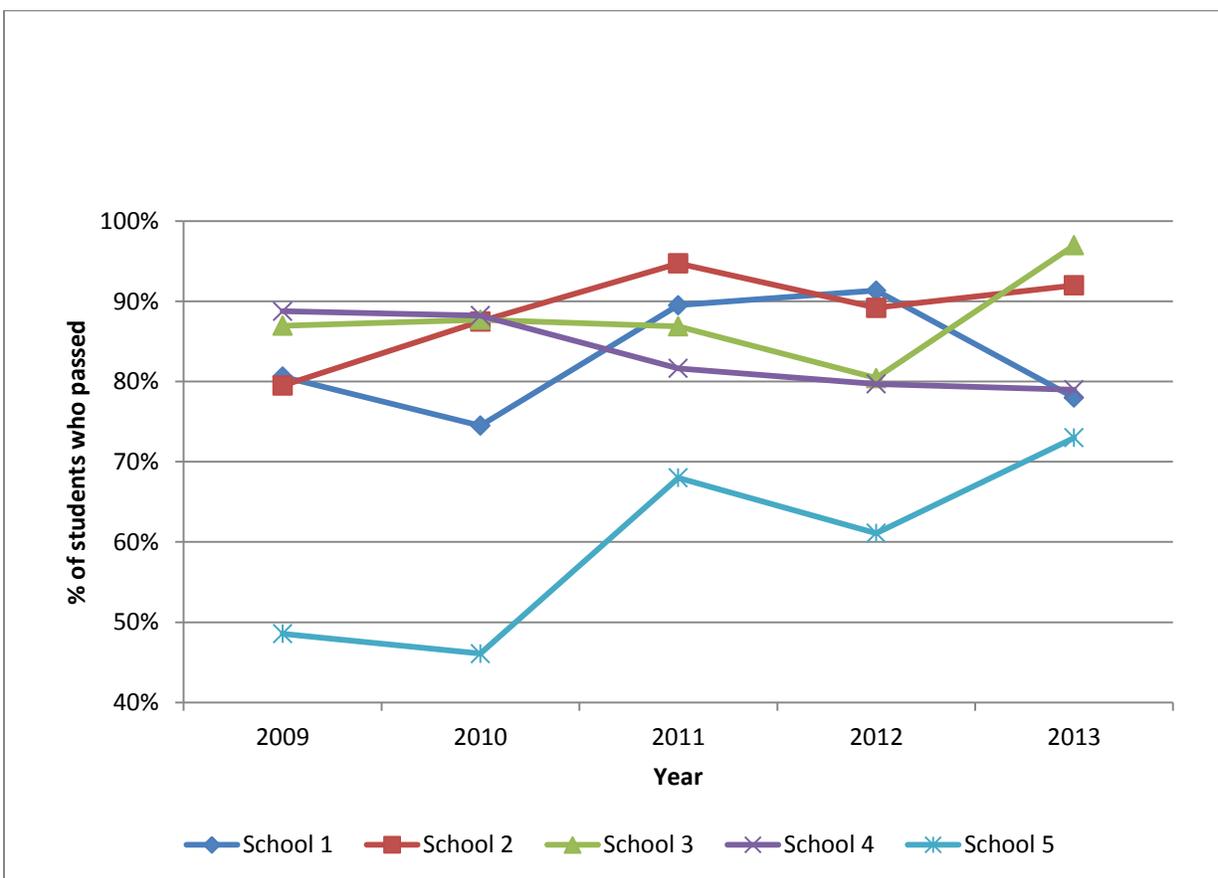


Figure 4.13 Graph of the percentage of learners who passed Grade 12 NSC Life Sciences

Figure 4.13 shows that the percentage pass rate in Life Sciences was very good at the beginning of the project in four of the schools. These four schools had their ups and downs but managed to maintain a fairly decent pass rate.

The success story that shouts out from Figure 4.13 above is that of school 5, who at their worst was achieving a pass rate of 46% in 2010 and then managed to increase it to 73% in 2013. Teacher 5 was very dedicated to the programme and attended all learning opportunities throughout the project. The learners in the 2013 cohort of school 5 also attended teacher/learner sessions. In the Likert survey undertaken with the teachers it was agreed that the work covered in the project was rooted in the NCS which triangulates well with the results shown here for Life Sciences in the National Senior Certificate.

School 3 started with a percentage pass rate of 87% which they managed to increase to 97% in 2013. School 2 moved from 80% pass rate in 2009 to 95% in 2011. In 2012 and 2013 they achieved 89% and 92% respectively

School 4 slowly dropped from 89% to 88%, 82%, 80% and then 79%. These results are still good but the trend is a worrying one that will hopefully begin to improve this year. School 1 achieved 81%, 75%, 90%, 91% and 78% for the five years. The cohort of 2014 is the group who had the most input from teacher/learner sessions.

#### **4.6 COMPARISON OF PROJECT SCHOOL PERFORMANCE WITH PROVINCIAL AND NATIONAL TRENDS**

In this section the project schools' Grade 12 results in the NSC for the three subjects are addressed and are compared with the results obtained provincially and nationally to control for provincial and national factors. By comparing the project school's results with the provincial and national results extraneous factors like national policies and practices are controlled for. Factors that influence Western Cape schools as a whole are also controlled for as the project schools are part of this province. They are subject to the same constraints placed on them by the Western Cape Education Department.

#### 4.6.1 Comparison of NSC Mathematics results

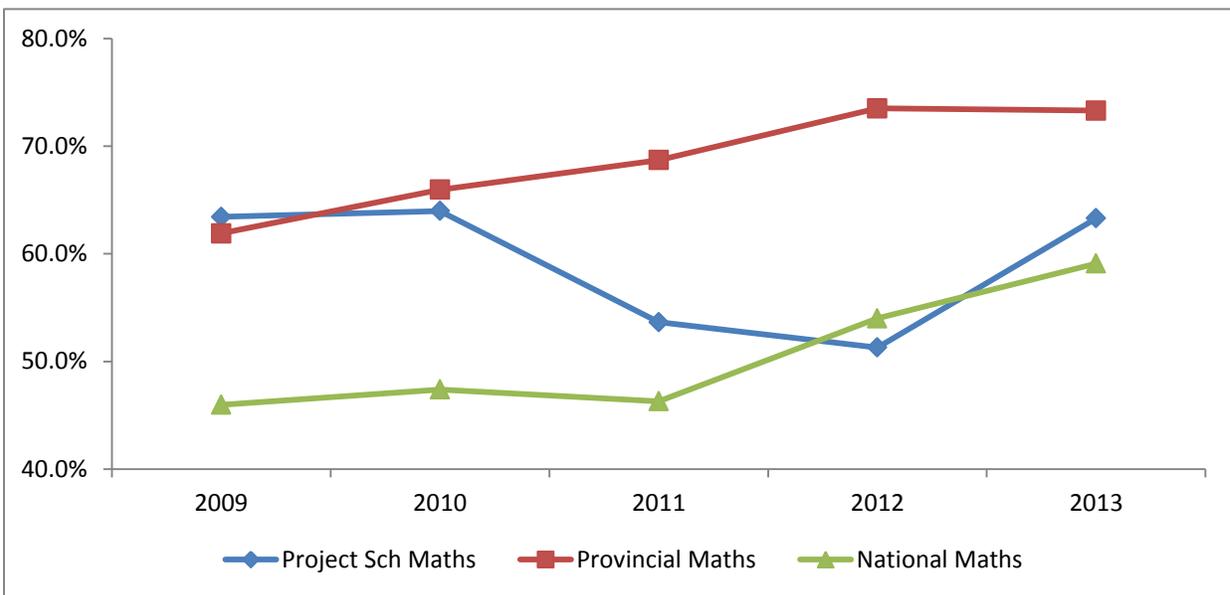


Figure 4.14: Comparison of average marks of all the schools in the project for Mathematics with provincial and national results

In Figure 4.14 it can be seen that the project schools started with 63,4 % of the learners passing which was marginally better than the 61,9% achieved by the province. In the next year the project schools manage to increase the pass rate ever so slightly to 64%, but in 2011 and 2012 decreased substantially to 53,6% and 51,3% respectively. The 2012 result was even below that of the country. In 2013 the project schools redeemed themselves with a result of 63,3% which is very close to what they started with in 2009 but it is still nowhere near the results of the province.

The radical drop in the results in 2011 and 2012 may have been due to key mathematics teachers who moved out of the project schools who showed the highest decline as seen in Figure 4.9.

#### 4.6.2 Comparison of Physical Sciences results

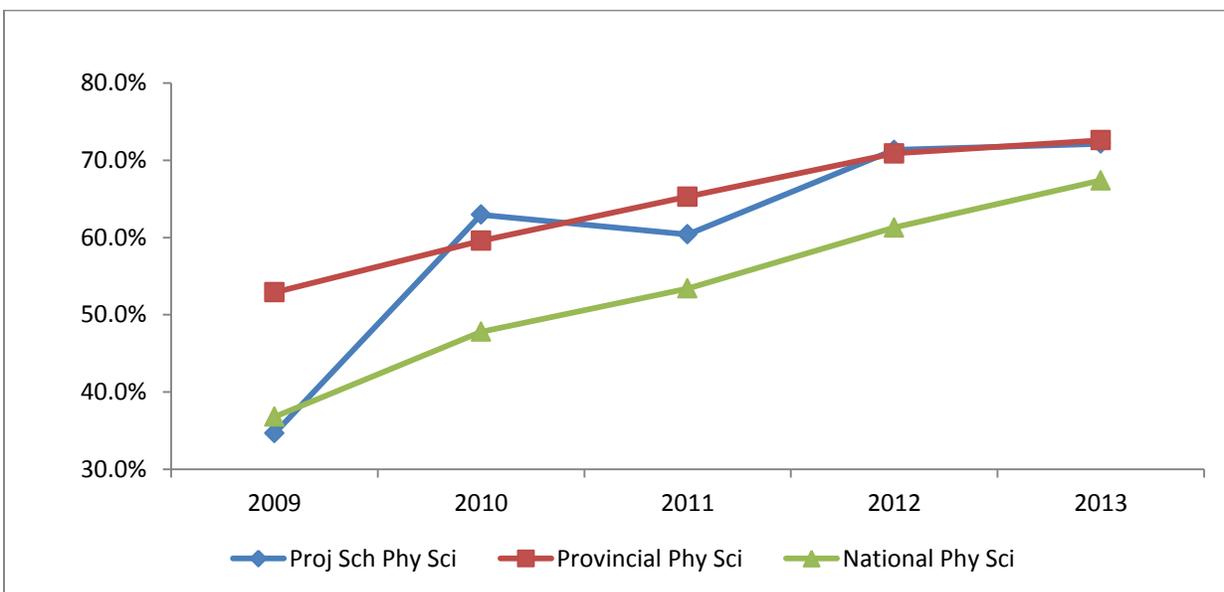


Figure 4.15. Comparison of average marks of project school results for Physical Sciences with provincial and national results.

Figure 4.15 shows that the project schools started in 2009 with a percentage pass rate of 34,7% which was worse than the national average of 36,8% and much worse than the provincial average of 52,9%. In 2010 the project schools outshone both the national results and the provincial results achieving 63%. In 2011 the project schools decreased to 60,4% but then increased in the next two years to a final result of 72,1% which was just below the provincial average of 72,6%.

### 4.6.3 Comparison of NSC Life Sciences results

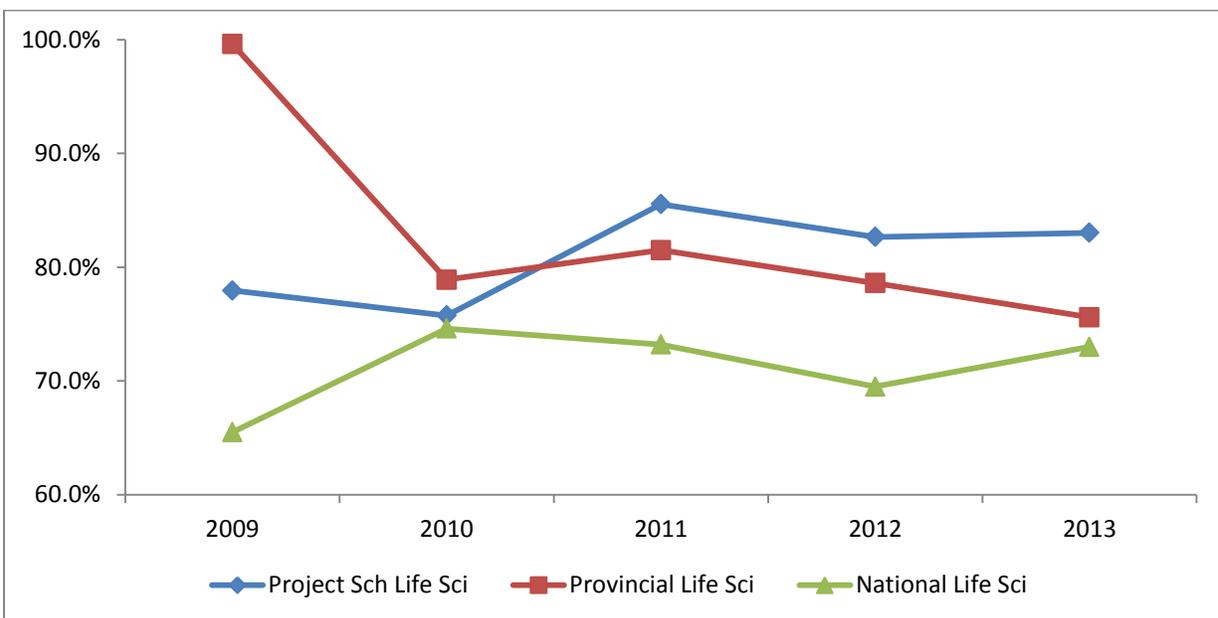


Figure 4.16: Comparison of average marks of the project schools for Life Sciences with provincial and national results

In Figure 4.16 it can be seen that the project schools outperformed the national and provincial results in 2011, 2012 and 2013. The highest result achieved was 85,5% in 2011. In 2012 and 2013 it was 82,7% and 83,0% respectively. 2009 was a phenomenal year for the province (99,6%) but the same cannot be said for the project schools although 77,9% is still very respectable.

## 4.7 SUMMARY

In this chapter the feedback from the three key recipients in the SMILES project were analysed and discussed. The main participants/respondents who contributed to this feedback were the principals of all the schools, the teachers involved in all the subjects that were addressed in the SMILES project and the learners who were part of the teacher learner sessions. The results that the different schools received in the three subjects in the National Senior Certificate were also presented and analysed.

The impact that the SMILES project had on learning in the five high schools was addressed by looking at the perceptions of the teachers, school management and learners. These perceptions were captured using Likert surveys and structured interviews. They were presented as transcriptions of audiotaped interviews and also graphically using bar charts and word clouds. The limitations of using word clouds were discussed and where necessary direct quotations were made when the word cloud did not make the intended message clear.

The five hierarchical levels of professional development evaluation as described by Guskey (2000) were discussed whenever applicable to the data being presented.

In the next chapter overall conclusions regarding the project will be made based on the results presented in this chapter. Recommendations for future projects and for future research will also be made.

## **CHAPTER 5**

### **SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 INTRODUCTION**

This chapter includes a summary of all of the preceding chapters and a summary of the main findings in answer to each of the research questions. Contributions to knowledge that the study makes in the field of Mathematics and Sciences teaching and limitations of the study are discussed. Based on the findings, knowledge contributed and limitations of the study, recommendations are made for in-service professional development practitioners, policy makers, schools and teachers. Recommendations for theory improvement and further research are also made.

#### **5.2 SUMMARY OF EACH CHAPTER**

The essence of each of the preceding chapters is summarised below.

##### **5.2.1 Chapter 1**

The rationale and context of the thesis was described in this chapter. The research questions that the thesis addresses were formulated based on the reasons for the research. Contextual limitations were also taken into account when the research questions were formulated.

South Africa has been performing dismally on a global scale in the so called gateway subjects, Mathematics and the Sciences. The situation in South Africa was sketched using the Mathematics and Sciences results from the National Senior Certificate and areas in need of improvement were highlighted. South Africa's poor performance in global tests suggests that the standard of education in South Africa is not up to standard. In an effort to address the standard of Mathematics and the Sciences teaching and learning IMSTUS (The Institute of Mathematics and Sciences Teaching at the University of Stellenbosch) initiated an intervention project called SMILES (Sciences and Mathematics Initiative for Learners and EducatorS). As the name implies the focus was on both teaching and learning. This research thesis aims to evaluate the SMILES project and based on this evaluation to make conclusions

recommendations for future interventions that seek to enhance teaching and learning of Mathematics and the Sciences.

The following research question and sub questions were formulated:

What was the impact of the SMILES intervention model on teaching effectiveness?

- a) What were the perceptions of the teachers regarding the impact of the intervention?
- b) What were the perceptions of the School Management Teams (SMTs) regarding the impact of the intervention?
- c) What were the perceptions of the learners regarding the impact of the intervention?
- d) What was the impact of the intervention on learning outcomes, if any?
- e) What other factors were significantly at play during the intervention?

Definitions of key terms, limitations, and delimitations of the study were sketched out, and an outline of the rest of the thesis was given.

## **5.2.2 Chapter 2**

In chapter two a literature study is undertaken to explore teacher professional development which was the crux of the SMILES project. Teacher professional development was introduced and relevant literature was analysed and presented as it pertained to this study. The purpose of teacher professional development was presented as well as the characteristics of effective professional development.

Shulman's ideas relating to professional development and to pedagogical content knowledge underpin the study. Courtney's characteristics for effective professional development were discussed. Guskey's (2003) five levels of professional development evaluation were introduced as a major component of the theoretical framework for this study. The questions to ask if these evaluation levels are satisfied were: firstly, what were the participants' reactions to the programme? Secondly, did the participants' learn new knowledge and skills? Thirdly, was there organisational support and change in the organisation? Fourthly, did the participants use and implement the new knowledge and skills and fifthly what was the impact on student learning outcomes?

The main goals of the SMILES project were discussed which were to promote constructivist learning environments, an understanding of the nature of science (NOS) among teachers, and the development of scientific argumentation as the process by which scientific knowledge ought to be constructed in mathematics and science classrooms. Professional development was defined from and the critical features of effective professional development drawing from various authorities including Courtney, Desimone and Guskey. From these various theoretical frameworks a conceptual framework for this study was synthesised.

### **5.2.3 Chapter 3**

In this chapter the research design and methodology of the evaluation research regarding the SMILES project was discussed. The concurrent mixed methods approach was adopted combining and triangulating the strengths of qualitative and quantitative paradigms to obtain a more complete picture of phenomena. The different methods and respective instruments used in this research were defined, justified and described and their strengths and weaknesses analysed. Data collection and analysis procedures together with sampling techniques used for each design or research method were described.

Examples of qualitative methods included structured interviews using open ended questions and learner responses to open ended questions of the survey questionnaire. Quantitative data were collected from the Likert type questions of the survey questionnaire and the DBE reports on the National Senior Certificate results for the years 2009 to 2013 to complement data obtained from schools.

### **5.3.4 Chapter 4**

In chapter four the results from the Likert surveys conducted with the teachers reading the project were discussed. The results were very positive so they were broken up further to make a distinction between agree and strongly agree. The statements that had the most responses for agree were then explained. The transcripts from the interviews with the principals were analysed and coded. These statements were unpacked and the context was sketched when needed.

The questionnaires given to the learners were analysed and bar graphs were drawn for the Likert survey. Each of the statements was then discussed. The responses to the open ended questions were transcribed and then fed into a word cloud generator. Key words that came out of the word clouds were made clear and the context was explained.

The archival results of the five schools NSC examinations were graphed and trends were discussed. These results were also compared with the province and the country. Results from the National Senior Certificate were presented for the five schools for the duration of the project and one year extra. Possible reasons for trends and anomalies were discussed.

### **5.3 SUMMARY OF MAIN FINDINGS**

In this section the main findings of each research sub question will be presented linking it to existing theory and literature. The research sub-questions contributed to addressing the main research question as already alluded to above, namely: What was the impact of the SMILES intervention model on teaching effectiveness?

#### **5.3.1 Perceptions of the teachers regarding the impact of the intervention**

Fourteen statements were made regarding the project and teachers had to respond on a Likert scale which ranged from “strongly agree” to “strongly disagree”. Thirty six (36) teachers answered fourteen (14) statements which means that there were a total of five hundred and four (504) responses made. Out of these responses all agreed or strongly agreed bar nine (9) who were neutral. All the statements made, were made positively which means that teachers were overwhelmingly positive about the project and the impact it was having.

The highest number of neutral responses (4) came from the statement that read “SMILES provides opportunities for teachers to interact with peers.” This could imply that the peer interaction afforded by SMILES may not have been enough.

Separating the “agree” statements from the “strongly agree” statements showed that two statements had more people opt for “agree” than for “strongly agree”. The first one

stated that SMILES afforded opportunities for individual reflection. This may show that more time is needed during professional learning opportunities for individuals to reflect on the material or the concepts being addressed. The second statement was regarding adequate time to address content and effective use of that time. Time spent and the effective use of the available time in any professional development setting is critical and must be monitored constantly. The SMILES teachers agreed that the time spent was effective and adequate.

### **5.3.2 Perceptions of the School Management Teams (SMTs) regarding the impact of the intervention**

Discussions were held with the principals of all the high schools that were in the project. The main ideas that came out was the acceptance of the SMILES facilitators in the classrooms, the learning opportunities that the teachers received and the need for work to be done with learners in the schools. Classroom visits by facilitators were well received by staff and they treated the facilitators as members of staff. This showed that the teachers were not intimidated by the fact that someone from a tertiary institution was coming into their domain. Strong collaboration between the teachers and the facilitators on the programme was clearly shown through co teaching and the involvement of facilitators during planning sessions. Principals were very grateful for the training that teachers had received and said that the teachers returned with new enthusiasm for their work. Fullan's (2011) idea of facilitators being more like coaches comes to mind.

One of the requests that principals made was that the project should somehow include learners in an effort to try and improve their results and learning skills. The argument was that learners from these schools could not financially afford extra tuition although in many cases it was dearly needed. The outcome of this was that "teacher/learner" sessions were introduced.

### **5.3.3 Perceptions of the learners regarding the impact of the intervention**

The results from the Likert survey done with the learners indicated that the outcomes that were hoped for in the project were being achieved. One hundred and sixteen learners out of a total of one hundred and twenty one learners (96%) said that teacher/learner sessions helped them understand the work better. In another statement that probed whether they were learning anything new in the teacher learner sessions 97,5% indicated that they were indeed learning something in the sessions. The excellent attendance at all the teacher learner sessions implied that they had a positive attitude towards the subject being offered.

Learners were also asked open ended questions relating to the teacher learner sessions. The most telling response that came through was that the SMILES project had helped them understand the work. They enjoyed doing the practical work and felt that they had a much better grasp of the subject after having done practical investigations. This is level 5 of Guskey's (2000) model of professional development evaluation and it is the outcome described by Desimone (2009) as improved student learning.

### **5.3.4 Impact of the intervention on learning outcomes**

As mentioned above, a deeper understanding of the work by the learners was one of the outcomes that the project hoped to achieve. The learners said repeatedly during the interviews and in the Likert survey that they had a better understanding of the work.

Analysis of the National Senior Certificate results of the project schools compared with the National and Provincial results indicated that the project schools on the whole fared better than the National results. When compared with the provincial results the project schools did better in Life Sciences. In Physical Sciences the project schools started with results below that achieved nationally (34,7%) and then ended up with a pass percentage within half a percentage point of the provincial result (72,1%). The Mathematics results were not as positive. The project schools started by achieving a 63,4% pass rate and ended with a percentage pass rate of 63,3% having taken a dip down to 51,3%. In the end the Mathematics marks were better than the national results but were 10% lower than the Provincial average.

It is impossible to say whether the above results are due to the SMILES project as there are too many variables involved that are impossible to control. One thing is certain and that is the attitude of the learners and the teachers toward their respective subjects improved during the project and this could have had a positive effect on the results achieved in the National Senior Certificate. Another fact is that the project schools all showed improvement in the latter half of the intervention which may have been partly due to the project.

### **5.3.5 Other factors at play during the intervention**

During the intervention there were many factors that affected the intervention directly but over which there was no control.

#### ***5.3.5.1 Soccer World Cup and Public Servants strike***

During 2010 the Soccer World Cup was hosted by South Africa. In order to make it possible for more South Africans to be a part of this amazing event the National Department of Basic Education structured the school holidays to be long enough to include the world cup. This was an effort to prevent absenteeism during the matches as well as free up some public transport that would have been used to transport school children. The winter school holidays were usually 3 weeks long but this year they were one day short of 5 weeks. This length of holiday was similar to the summer holiday in December and January which is the longest holiday in the school calendar. This in itself was not a bad thing but it did require a huge effort to get back into work mode for most of the country.

One month after returning to work after the Soccer World Cup holiday public servants went on strike against the government as salary negotiations had come to a standstill. The strike lasted three weeks during which most schools across the country were closed or operating on skeleton staff. This affected the intervention directly for two major reasons. Firstly facilitators could not gain access to schools and with few teachers present there was no point in conducting school visits. Secondly, although learners could still attend school, in many areas it was not safe to do so. As a result of this all teacher/learner sessions were cancelled during the strike. Thirdly, when the strike was over the teachers had a huge amount of work to catch up and as such could

not attend any workshops or training sessions. These were also cancelled. Fourthly, the loss of teaching time meant that teachers slipped very easily back into less effective teaching methods in order to “cover” the work and not necessarily teach in such a way to ensure that learning took place. Strangely enough, in spite of the long holiday and the strike the national results in the National Senior Certificate continued to improve in the three subjects targeted by the SMILES intervention. In Mathematics and Physical Sciences the provincial and project schools marks improved from 2009. In Life Sciences, however, this was not the case and the project and provincial results decreased.

#### ***5.3.5.2 Teacher turnover***

During the intervention, teachers moved to other schools, some resigned and in one case a teacher left the school system for a year and returned in the final year of the project. Teachers would also not necessarily teach the same subjects each year but would be assigned duties by the school management according to the needs of the school. Over the four years there were three out of a total of fifteen Physical Sciences teachers who remained in the project throughout. The situation was slightly better in Mathematics and Life Sciences. Every time a teacher moved or changed subjects, the project facilitators would need to build the relationship once more with the replacement. One also had to begin again with the training of the new teacher as the skills and knowledge that was handled with the original teacher had obviously been missed by the new teacher. However, all was not lost when a teacher moved as hopefully they would implement what they had learnt in the project wherever they were employed.

#### ***5.3.5.3 Teacher contact time with learners***

In the first year of the project it was allowed by the WCED to take teachers out of the school during school for further training and professional development. Because we understood that the current learners would not see the benefit of this as they would lose teaching time with their teachers, we decided to schedule our professional learning opportunities for teachers during the examinations. During examinations teachers would be marking scripts and invigilating which meant that contact time would not be lost.

In the next year of the project the WCED said that this too was unacceptable as it overloaded the teachers who were left behind with extra invigilation. It was therefore decided that all training would take place after school hours. Most of the professional learning opportunities were then scheduled to take place from 15h00 on a Friday until the same time on a Saturday sleeping over at the training venue. Work continued until about 21h00 on the Friday and would begin again at 08h00.

The above scenario worked surprisingly well but the biggest challenge was to find suitable dates that did not clash with school sport, WCED workshops and other weekend commitments that teachers had.

#### ***5.3.5.4 Promotion of Principal***

In school number five the principal who had agreed to and who had bought into the intervention was promoted and left. As a result an acting principal was appointed who had to become orientated with the project. For a full year this position remained vacant when finally it was filled. This instability in the school management did not help matters in the school or in the intervention, but the facilitators still managed to continue with school visits and teacher learner sessions.

## **5.5 LIMITATIONS OF THE STUDY**

### **5.5.1 Bias**

A common problem with small scale studies is that they are not representative enough of the larger population. Convenient sampling such as the one used in this study is an acceptable example of biased sampling but it is a limitation. Apart from geographical proximity as a cause of bias, the fact that disadvantaged schools only were targeted was another source of bias. We also stated that functional schools were needed or schools where at least 60% of the learners passed the NSC examinations where the chance of success would be higher. This is another source of bias.

### **5.5.2 Hours spent in Professional development learning opportunities.**

The number of hours of each project teacher's participation in contact sessions was not systematically recorded over the four years. This is a methodological limitation which if it had been thought of at the time one could see the effect that time spent on

professional development had on classroom practice or classroom culture (Supovitz and Turner, 2000).

### **5.5.3 Financial**

In any study there is always a financial constraint as was the case in this intervention. The intervention was restricted to five high schools and their ten feeder schools. If the project could have been expanded to include more schools in the area it may have had a bigger impact on the student learning outcomes of the area. The schools were also selected for their proximity to Stellenbosch with the furthest schools being located in Paarl, some 32km away.

Three subjects were addressed at the FET level. If there was more funding available the other subjects offered at each school could have also been addressed as was requested by the other teachers in the school. It was decided to focus on Mathematics and the Sciences as these were the subjects that are regarded as gateway subjects for access to tertiary institutions especially for qualifications in the Medical fields and the Sciences.

Only 30 learners per subject per school were selected for the 10 teacher learner sessions per year. It may have made a much greater impact on the school's National Senior Certificate results if the teacher learner sessions could have been expanded to all the learners in the Further Education and Training band.

### **5.5.4 Available time**

As was discussed in paragraph 5.3.5.3 the only available time for the teacher professional development learning opportunities was after school hours as all of the teachers involved were already qualified and working in schools. This was in-service training and therefore the training had to be fitted into the schedules of the five schools involved.

### **5.5.5 Teacher Turnover**

Teachers were not bound to the project for its duration as seen in paragraph 5.3.5.2 which meant that if a teacher moved they were lost to the project. The project was committed to working with specific schools and could therefore not follow the teachers

wherever they went. This limitation was created because the schools were chosen and so by default only the teachers in these schools were part of the project.

### **5.5.6 Causality difficult to prove**

The biggest limitation in this study was that it is difficult to prove that the SMILES project was responsible for either the success or failure achieved in the project schools. Isolating all the variable is not an option as we are dealing with human beings who cannot be treated like machines. There are too many outside influences that can have an effect on student learning outcomes. Even if it was possible to list all these outside influences it would not be possible to determine to what extent they influence the learning process as people react differently to different situations. In true experimental designs where all factors are controlled, from random sampling to controlled implementation, it would possible to determine the proportion of the dependent variable explained by the independent variable (intervention). By performing regression analysis we could determine the regression equation, the regression correlation coefficient and finally r-squared which would tell us by how much percentage of the dependent variable is explained by the independent variable. This is referred to as determining effect size (Cresswell, 2009; Babbie and Mouton 2001; Gay et al 2006). In fact r-squared is actually called the coefficient of determination precisely for that reason.

The main ethical dilemma with educational research is whether it is ethically acceptable to have a classical control group as one would be helping one and denying help to another. The closest is the use of randomised trial groups. These are very expensive to work with and are often undertaken in large scale studies with substantial funding. TIMSS is an example of such a large scale study in which SA participates.

## **5.6 GENERAL RECOMMENDATIONS**

### **5.6.1 Practitioners**

As was seen in the Likert surveys given to the teachers, they valued being treated as professionals as would anyone who is in a professional. Teachers valued support in the classroom, and not just criticism but genuine support to overcome the challenges that they face. The notion that teachers will not accept people into their classrooms is true if the motivation behind the visit is criticism and inspection. If the motivation is to

help, guide and find better ways of teaching together in a supportive way then teachers welcome one into their domain.

When facilitating a workshop the material is often the overriding factor and getting through the material is often the concern for most facilitators. As was seen in the feedback from teachers they valued time to reflect individually on the work and with each other before the next work is handled. Sufficient time allocated for reflection individually and as a group is recommended in teacher professional learning opportunities.

### **5.6.2 Funders**

In the SMILES project the funders understood that the facilitators and project management had the insight and the expertise to best shape the project in order to attain the set outcomes. The funders understood that the circumstances changed during the project and that there would be different needs at different stages in the project. Therefore they gave the leeway and flexibility to the implementers of the project to channel funds as was needed. It is recommended that funders, like the funders of this project, heed the feedback from the practitioners and give them the flexibility to nuance the spending of the funds to best suit the attainment of the agreed outcomes.

### **5.6.3 Policy Makers**

It is critical to involve the Department of Education as much as a major stakeholder in a project of this nature. The local provincial education department, the Western Cape Education Department (WCED), has a more global picture of what is going on in all the schools in the community and will be able to guide practitioners in the needs of the wider community. The more the WCED is involved the more teachers and schools buy into the product being offered. All professional learning should be aligned with the policies set by the Education Department. This is in line with one of the core features of effective professional development as described by Desimone (2009) when she speaks about coherence. Coherence is described by Desimone as the extent to which the content taught in the professional development setting is consistent with the reforms and policies of the education authorities. The curriculum being taught during

the professional learning events must be aligned with the curriculum being taught in the schools which will immediately make the opportunity relevant and applicable to teachers. This would apply to Guskey's (2000) fourth level where the teacher begins to change classroom practice and apply what was learnt.

#### **5.6.4 Schools**

Ideally it would be better for the project if teachers chose the professional development initiative and not the service provider choosing the teacher or school for following three reasons. Firstly because teachers choose and are not coerced by the management or facilitators they will be more willing and will show a greater buy in towards the project. Secondly if the teacher should move that teacher could continue with the programme. Thirdly the teacher is well aware of his or her weaknesses and can decide themselves whether or not to deal with them. When the service provider selects the schools or participants then it could be construed that the service provider is saying that the teacher or school is below par and need an intervention to fix the situation. In the case of the SMILES project it was offered to ten schools. Based on the responses from those ten schools the five project schools were selected. Therefore in essence the schools chose the intervention and not the other way around.

If teacher/learner sessions are going to be used it would be better if the learners are given pre- and post-tests to determine the learning gains. The learners in the SMILES project were selected based on their school marks, but if they wrote a specific pre-test on entering the teacher learner programme it may have given the programme a higher status within the schools. This could have motivated the learners selected to work harder to retain their position and it could also have motivated others that were not part of the programme to try harder.

#### **5.6.5 Teachers**

The professional development training of the teachers was not coupled with any accredited programme or short courses. The material chosen for the workshops was based on a "needs analysis" conducted in the schools or at a prior workshop. These sessions presented courses that were not accredited or aligned with any other

professional qualification. If the courses are accredited and aligned it could result in a bigger buy in from teachers.

## **5.7 Further research**

### **5.7.1 Model applied to all schools**

Larger samples with none of the biases described in the limitations above would be a welcome further development to this project. It would be interesting to work with a teacher and all of his or her learners using co-teaching, lesson observations, teacher professional learning and teacher/learner sessions with all the learners associated with that teacher and not just the learners who are gifted.

### **5.7.2 Intervention Length**

More research could be undertaken to determine the optimal length of the intervention and how many sessions it should contain. This research would have to be coupled with specific content so that it could be replicated with different groups in different contexts.

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# ADDENDUM A

## Teacher Learner Evaluation Practical ways to construct knowledge

September 2012



### Sciences and Mathematics Initiative for Learners and Educators (SMILES)

Strongly disagree / *Verskil sterk*

Disagree / *Verskil*

Neutral / *Neutraal*

Agree / *Stem saam*

Strongly agree / *Stem sterk saam*

#### Workshop material

The material

1. is linked to the curriculum.
2. is suitable for use by educators.
3. is compiled in a learner-centered way.
4. is appropriate for the construction of knowledge.
5. can be used to develop learners' knowledge and skills.
6. could be used for group work.


#### Presentation:

7. The venue and time span was suitable for the purpose.
8. The hands-on approach added value and helped to consolidate my knowledge.
9. The teaching strategies used are appropriate for my use.
10. I had enough opportunities in my group to contribute ideas and ask questions.
11. The information was presented effectively.


#### Personal:

12. I now have more knowledge than when I first arrived.
13. I had the necessary subject knowledge to keep up.
14. The workshop adequately addressed my content knowledge.
15. The workshop addressed alternative didactic skills suitable for me to construct knowledge.
16. The workshop added to my professional development as a teacher.
17. I now feel more confident to teach my learners.


## ADDENDUM B



### Professional Development Evaluation February 2009 - November 2010



**CONTEXT**

School: .....

Subject : .....

Total no. years of teaching subject: .....

Academic and professional qualifications: .....

Male / Female: .....

Using the following scale please respond to the statements listed below:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

Statement	Code
1. Training received from the Smiles/CLIMMB Project is ongoing.	4
2. Smiles/CLIMMB has included training, practice and feedback.	5
3. Smiles/CLIMMB has afforded opportunities for individual reflection.	4
4. Smiles/CLIMMB is school based and applies to teacher's work.	4
5. Smiles/CLIMMB is collaborative.	4
6. Smiles/CLIMMB provides opportunities for teachers to interact with peers.	3
7. Smiles/CLIMMB focuses on educators in order to enhance learner's understanding.	4
8. Smiles/CLIMMB encourages and facilitates school-based teacher initiatives.	4
9. Smiles/CLIMMB training is rooted in the NCS.	5
10. Smiles/CLIMMB training builds on existing knowledge and skills frameworks.	4
11. Smiles/CLIMMB facilitators treat educators as professionals in their field.	5
12. Smiles/CLIMMB training is time effective and provides adequate time to address the content.	3
13. Smiles/CLIMMB provides follow up support of educators after training has taken place.	4
14. Smiles/CLIMMB training is accessible and inclusive of all in the project schools.	4

In your opinion what are the strengths of the SMILES/CLIMMB project?

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And the weaknesses?

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Thank you for your time and for giving us this valuable feedback.

## ADDENDUM C

### Teacher Learner Evaluation



Sciences and Mathematics Initiative for Learners and Educators  
(SMILES)

1. Next to each of the following statements, please indicate whether you strongly agree(SA), agree(A), disagree(D), strongly disagree(SD) or undecided(U). The first one is done as an example.

Statement	SA	A	D	SD	U
A snake has armpits.				X	
I try to attend all teacher learner sessions.					
Teacher learner sessions are usually boring.					
I only attend because of the free refreshments.					
I usually learn something during the teacher learner sessions.					
I wish we could have more teacher learner sessions.					
Teacher learner sessions confuse me.					
Teacher learner sessions teach us the work in practical ways.					
I understand things better when they are shown practically.					
The best sessions were those where we did the practical ourselves.					
I get the chance to express myself during teacher learner sessions.					
The facilitators are professional in the way they teach and treat us.					
The work done in teacher learner sessions was relevant to the work we did in class.					
Teacher learner sessions help me understand the work better.					

**2. Which teacher learner sessions helped you the most?**

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**3. What are all the positive things that you can think of regarding Teacher Learner sessions?**

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**4. What can be done differently to improve teacher learner sessions?**

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**5. Write down any general comments that you would like to make about teacher learner sessions or the SMILES project.**

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## ADDENDUM D



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Jou kennisvenoot • your knowledge partner

### Approval Notice New Application

30-Sep-2013  
Fair, Andrew AG

**Proposal #:** DESC\_Fair2013

**Title:** An evaluation of the model of professional development of teachers in a Sciences and Mathematics Initiative for Learners and EducatorS (SMILES) at the University of Stellenbosch.

Dear Mr. Andrew Fair,

Your DESC approved **New Application** received on **19-Aug-2013**, was reviewed by members of the **Research Ethics Committee: Human Research (Humanities)** via Expedited review procedures on **27-Sep-2013** and was approved.

Please note the following information about your approved research proposal:

Proposal Approval Period: **27-Sep-2013 -26-Sep-2014**

Please take note of the general Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

Please remember to use your **proposal number** (DESC\_Fair2013) on any documents or correspondence with the REC concerning your research proposal.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Also note that a progress report should be submitted to the Committee before the approval period has expired if a continuation is required. The Committee will then consider the continuation of the project for a further year (if necessary).

This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki and the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health). Annually a number of projects may be selected randomly for an external audit.

National Health Research Ethics Committee (NHREC) registration number REC-050411-032.

We wish you the best as you conduct your research.

If you have any questions or need further help, please contact the REC office at 0218839027.

**Included Documents:**

DESC form  
Permission letters  
Assent form  
Interview schedule  
Research proposal  
Informed consent parents

Sincerely,

Susara Oberholzer  
REC Coordinator  
Research Ethics Committee: Human Research (Humanities)

## ADDENDUM E



Directorate: Research

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**REFERENCE:** 20130605-12251

**ENQUIRIES:** Dr A T Wyngaard

Mr Andrew Fair  
20 Immelman Street  
Somerset West  
7130

**Dear Mr Andrew Fair**

**RESEARCH PROPOSAL: AN EVALUATION OF THE MODEL OF PROFESSIONAL DEVELOPMENT OF TEACHERS IN A SCIENCE AND MATHEMATICS INITIATIVE FOR LEARNERS AND EDUCATORS (SMILES) AT THE UNIVERSITY OF STELLENBOSCH**

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Approval for projects should be conveyed to the District Director of the schools where the project will be conducted.
5. Educators' programmes are not to be interrupted.
6. The Study is to be conducted from **10 June 2013 till 20 September 2013**
7. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
8. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
9. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
10. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
11. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
12. The Department receives a copy of the completed report/dissertation/thesis addressed to:

**The Director: Research Services  
Western Cape Education Department  
Private Bag X9114  
CAPE TOWN  
8000**

We wish you success in your research.

Kind regards,  
Signed: Dr Audrey T Wyngaard  
**Directorate: Research**  
**DATE: 05 June 2013**

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tel: +27 21 467 9272 fax: 0865902282  
Safe Schools: 0800 45 46 47

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Employment and salary enquiries: 0861 92 33 22  
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