IMPROVING SCIENCE EDUCATION IN ZIMBABWE: THE ROLE OF RESOURCE TEACHERS IN PROFESSIONAL DEVELOPMENT

Ken Chavunduka

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IMPROVING SCIENCE EDUCATION IN ZIMBABWE: THE ROLE OF RESOURCE TEACHERS IN PROFESSIONAL DEVELOPMENT

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geboren op 27 mei 1960

te Bulawayo

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PREFACE

My PhD trajectory, starting in 1998, has been long and loaded with both excitement and disappointments. There are so many times along this trajectory when I felt like giving up. I am glad, however, that I did not listen to the spirit of defeat. It now gives me so much pleasure to reflect and acknowledge all the help and facilitation I got along the way.

This work would not have been possible without the funding I received from three organizations. NUFFIC through the SEITT project made it possible for me to do all the preliminary work till the end of 1999. My studies could have ended at this point but thanks to the Royal Netherlands Embassy who sponsored SEITT II from which I received further support through to 2002. Finally the Department of Curriculum at the University of Twente helped me to go through the crucial and final stages of this study. To all these organizations I say *Dank u heel veel.*

The secretariat at the Department of Curriculum, Petra Zuithof, Sandra Schele and Minke van der Put who always worked hard to ensure I got the numerous visa documents I needed over the years as well as accommodation bookings and an office to work in. Sandra Schele also made the layout for this book. My thanks also go to Dionysia Loman and Francis Leusink, the two ladies in the international office that always facilitated my visa applications, and those extra utensils I needed each time I stayed in Macandra. *Dames, dank u zeer.*

In Zimbabwe, my sincere thanks go to all the Ministry of Education, Sport and Culture personnel at head office who granted permission for this research to be done, especially Dr. S.M. Mahere, who supported SEITT throughout its implementation and research endeavors. I would also want to specifically thank all the science and mathematics education officers, the heads of SMC host schools and all the RTs and teachers who were my data sources in the three case provinces of Manicaland, Mashonaland Central, and Matabeleland North (Bulawayo). Tatenda/Siyabonga.

I consider myself priviledged to have been supervised by Professor Jan van den Akker and Dr. Ellen van den Berg. This team of supervisors worked along with me all the way, providing tips when the going got tough as well as provided that inspiration to soldier on. As a non regular student of the University of Twente, I was often gone for extended periods of time, thus breaking my writing rhythm. Each time I came back, however, these two were always ready to break into it, and move along with me. For your patience and ever ready assistance, I thank you.

My heartfelt thanks go to my wife, Servie, who always stood by me throughout my research and writing and so ably attended to all family matters whenever I was away, especially attending to Michelle and George's educational needs at the period they needed me most. Together with my family, I thank God through Christ who strengthens me.

Enschede, September 2005

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This chapter introduces the Resource Teacher (RT) study. The study is in the field of teacher professional development. It aims at an evaluation of RT implementation of the Science Education In-service Teacher Training (SEITT) project. Section 1.1 gives a flavour of schooling practices in Zimbabwe. Section 1.2 analyses elements of those schooling practices. Problems of teacher qualifications, teaching practices, shortage of teaching materials and A-level graduates are discussed, including the role of examinations in contributing to a lack of teaching with understanding. Section 1.3 discusses the Ministry of Education's acknowledgement of poor quality teaching in Zimbabwe's schools. The SEITT project, a model for in-service of teachers in Zimbabwe, is introduced in section 1.4. The aim of this study is given in section 1.5. Section 1.6 outlines the research approach. The chapter concludes by providing an overview of the subsequent chapters.

1.1 SAMPLING SCIENCE TEACHING ENVIRONMENTS

I invite the reader to visit a typical government financed high school in Zimbabwe. Your visit will focus on the availability of teaching materials and classroom practice. Through this visit you will also get a feel of what a typical A-level Zimbabwean teacher thinks about his/her job. Only two teachers will be visited.

VIGNETTE # 1: TEACHERS AND TEACHING ENVIRONMENT

You have ascertained that A-level teachers at Bafundiseni High School have university degrees in their teaching subjects but do not have professional teaching qualifications. You then decide to visit the school to meet some teachers and observe one or two lessons in session. The school head of Bafundiseni refers you to Vusa, a male physics teacher. In your conversation with Vusa you ask a number of questions, one of which is how he decided to get into the teaching field. *"I had other ideas for a career when I went to university. At completion of my studies, teaching is all that was available. I'll leave as soon as I get a better job",* Vusa replies.

You then ask Vusa to show you around his laboratory. He opens a few cupboards and retorts, *"See! All these cupboards are almost empty. I tried to use this Wimshhurst[1] machine last week for a demonstration but it wasn't working. The technician tells me it hasn't worked for the past five years! I wonder why they keep him anyway. He's useless"*. After this brief tour you sense frustration in Vusa's responses. That makes you even more curious and you decide to ask Vusa if you could stay on in his physics lesson. He reluctantly agrees.

VIGNETTE # 2: TYPICAL LESSONS

A LOWER SIXTH PHYSICS LESSON

The bell has just rung and fifteen boys and just one girl, all smartly dressed in their uniforms, enter the laboratory and sit down. They immediately reach into their satchels and pull out their plastic covered fifth editions of Nelkon and Parker's "Advanced level Physics". You notice that just half the class has this textbook, and mind you it's the year 2001 and a seventh edition of this textbook has been on the market for at least two years. The students also pull out neatly covered exercise books and pens. After the teacher has introduced you he opens the lesson by asking three questions. The responses are in standard textbook language with no request for elaboration from the teacher. The teacher then turns to the green board and starts writing notes for today's lesson. You smile to yourself because it has become clear why students took out their exercise books without any prompting from the teacher. There is a standard routine in this class. The rest of the lesson is made up of long stretches of writing and brief instances where the teacher stops writing to explain his notes. When the siren sounds, your level of curiosity is still high, and you ask the teacher to introduce you to another staff member who might have a practical lesson that day. Miss Dombo is on that afternoon and agrees to your intrusion.

AN UPPER SIXTH CHEMISTRY PRACTICAL LESSON

You decide to get to the laboratory 15 minutes before the lesson starts. To your surprise there is some impressive glassware lined up on the side table. There are two stations on either side of the teacher's table—the acid station and the alkaline station. The phenolphthalein indicator is right in front of the teacher. Miss Dombo has just finished writing a detailed list of practical instructions on the board.

The siren sounds and a more favourable gender mix of students walks in. After the formal greetings the teacher goes straight into explaining what the practical is all

[1] A physics apparatus that generates and concentrates electric charge and produces a discharge across two points.

about and points to the two stations where the students are to fetch their chemicals. "*This is all the indicator I've got. No group should do more than three titrations otherwise there won't be enough to go round*", Miss Dombo says as she waves the indicator bottle for the class to see. She also points out potential chemical hazards and then instructs the students to go into their usual groups. As you observe the students at work, you notice a particular feature common to most of the groups. Most of the girls are data recorders, one of the boys is manipulating the apparatus and calling out the measurements, and the third boy or girl is helping confirm the measurement or just observing the other two at work, or just telling a joke. When the students have finished their titrations and put away the apparatus, the teacher gets a sample of results from one group of students and shows the class how to process the results of a typical titration experiment. End of lesson.

VIGNETTE # 3: A-LEVEL GRADUATES

One day your one and only favourite TV station is showing a panel discussion. The quality of sixth form graduates is on the agenda. Among the panellists is the deputy Minister of Education, Sport and Culture (MoESC), a science lecturer at the local university, and an industrialist. The lecturer and the industrialist are asked to comment on the quality of sixth form graduates since they come to them for university and employment, respectively. This is what they say:

Lecturer: All my incoming first year students are familiar with laboratory rules and regulations. Their scientific language is definitely far more developed than was the case during my time and I do not have to teach them scientific procedure. My biggest worry though is their lack of understanding of what they seem to know.

Anchor: What do you mean by "their lack of understanding of what they seem to know"?

Industrialist: "I'll tell you what he means. They can't recognise the real thing that they seem to know". He says that in obvious reference to their overly theoretical science education.

There is a power cut and the rest of the programme is lost. You wonder for the rest of the evening what the minister was going to say in reply.

Although the vignettes are fictitious, they give a realistic portrayal of the real situation in Zimbabwe's schools. Consistent with this evaluation study, I have raised

issues such as teacher qualifications, pedagogical content knowledge, material provision for effective teaching and learning, and the quality of learning activities. Section 1.2 looks at each vignette and points out some of the issues that plague Zimbabwe's high schools.

1.2 ANALYSIS OF THE VIGNETTES

1.2.1 A-LEVEL TEACHERS AND MATERIAL PROVISION

TEACHER QUALIFICATIONS

This section and the rest of the study will make reference to A-level teachers by their qualifications, since this aspect is recognised in the study as one of the many variables affecting the quality of teaching. For the purpose of this study, various groupings of teachers can be identified. The first lot of teachers holds either a Bachelor's degree in education (BEd.) or a licentiate degree (Lic.) in a particular teaching subject. All holders of BEd degrees are trained secondary school teachers who went through a one- or two-year course at the University of Zimbabwe (UZ) which was meant to upgrade their content level so that they can teach A-level science and mathematics. The Lic. holders are all Zimbabweans who were trained in Cuba under a special co-operation agreement to help solve the shortage of teachers of science and mathematics. These two degrees, do not provide teaching subject content to a sufficient depth to enable teaching the subject at A-level. A number of these teachers have since given up teaching A-level sciences and mathematics.

The second lot of teachers has a Bachelor of Science (BSc) degree in a science or mathematics subject but without a graduate diploma in education (GradDE[2]). These are rich in content but have no basic training in education. These will be referred to as "content" teachers. The BSc plus GradDE holders are in the category of trained teachers. These teachers are, however, different from the first category in that they are rich in subject content knowledge.

Due to the downturn of Zimbabwe's economy in recent years, university graduates have been turning to teaching in large numbers. Most of these university graduates had some career in mind when they undertook their university education. This, coupled with the fact that teaching is one of those careers with extremely low salaries, must leave these graduates a frustrated lot. Vusa is one of these frustrated

[2] A course that a university graduate with a subject specific degree must fulfil in order to qualify as a trained teacher.

teachers who will get out of teaching at the earliest possible opportunity. For now he will tolerate teaching since it is the only job available.

THE SHORTAGE OF TEACHING MATERIALS

Most of the educational material and equipment used in Zimbabwe's schools is imported. The slow down of the economy has caused schools to experience a stagnation or slow rise in per capita grants in the face of soaring inflation. This has also led to a scarcity of foreign currency to pay for the import of educational materials. As a result, apparatus and materials are priced beyond what most schools can afford. At the time those schools attained A-level status, they had sufficient materials and apparatus, but most of the consumables have not been replenished regularly. The apparatus has since broken, some parts misplaced by teachers or pilfered by students. When it is still there, ignorance of use by both the teacher and his laboratory technician is sometimes a problem. Vusa's complaint about the quality of technicians is also a contributing factor. This scenario is compounded by the fact that many teachers are not trained in improvisation of apparatus and creative teaching.

The in-service scene is therefore comprised of a mixture of trained teachers, content teachers, and teachers who might have teaching subject deficiencies. All these teachers work in an environment that is inadequately supplied with the necessary materials and equipment. Competent teacher support services such as laboratory technicians are also not available.

1.2.2 CLASSROOM PRACTICE

In their overview of research concerning life in science classrooms, Tobin, Tippins, and Gallard (1994) identify a number of practices. Three of the practices are emphasis on completion of content, emphasis on examinations, and failure to link practical work with theory. These practices were noticed in Vusa's and Miss Dombo's classes. Firstly, Vusa sees lecturing as a way of delivering content and emphasising textbook presentation of science concepts as the most efficient way of presenting content since it is often concise. Teacher notes are seen as a way of focusing content so that it is in line with syllabus specifications. Everything else outside the syllabus tends to be seen as "noise" that must be ignored. The focus is on the subject, not the student. Examinations measure how much students have learned and understood as a result of learning. Using examinations to pace learning and decide on content is not consistent with learning for understanding. Due to his lack

of professional teaching qualifications, Vusa's teaching style is perhaps consistent with the way he himself was taught, and hence he does not know any better.

The practice of holding separate practical sessions where the practical exercises are divorced from theory does not help in teaching for understanding. Practical work is therefore viewed, not as related to scientific concepts, but as a procedure for determining something. This view promotes the cook book (mechanistic) kind of practical lessons that our observer made in Miss Dombo's class. Her emphasis on the quantity of indicators communicates to students that they should do only the prescribed number of titrations. There is no room for student creativity or satisfying curiosity. Therefore, no matter how much relationship to other indicators or acid base relationships that a student might see, there are not enough materials to try anything extra. The learning techniques of bridging and elaboration are killed before they are born.

1.2.3 A-LEVEL GRADUATES

The shortage or complete absence of teaching materials in sciences coupled with the use of teachers without professional training has grave consequences for the students. The observation by the university lecturer and the industrialist on the panel discussion is the result of this.

It has been my personal observation that Zimbabwean children are fairly good at figuring out what the teacher wants and in solving problems related to examples that teachers might have worked out in class without necessarily understanding the underlying concepts. This ability is reflected in the general pass rate that averages 60% (A-E grade range) per year. Only 10% of these graduates are within the A-B grade range (Ncube & Engels, 1995). The lack of understanding of concepts becomes clear when these students, with a seemingly reasonable pass at A-level, have problems understanding related concepts at university and cannot recognise an electric motor in industry even though they can tell you how one works and where it is used. Such textbook dominated teaching and learning surely does not adequately prepare students for a future dominated by technological advances.

The nature of and preparation for examinations adds to the problems of teaching and learning with understanding. Teachers and students spend the last two months before A-level examinations engaged in revision exercises that involve studying past papers, 'spotting' what questions are likely to come, and practising solving related

problems. This practice encourages mechanistic and rote learning, practices that do not auger well for learning with understanding. The fact that some of these students go on to pass their A-level examinations suggests to subsequent students that such rote practice is beneficial. Since the quality of teaching is often judged by a teacher's results, it is unlikely that teachers will change what appears to be working.

The problems of teaching material shortage, rote learning practices, and emphasis on examinations all contribute to the lack of teaching and learning with understanding.

1.3 INITIATIVE FOR THE SEITT PROJECT

It is clear from the above vignettes and discussions that Zimbabwean students have been getting a raw deal from the educational system. Whilst the vignettes suggest that poor classroom practices are a result of professionally untrained teachers, a study by Ncube and Engels (1995) showed that there is little difference in teaching practices between professionally trained and non-trained teachers in Zimbabwe. Due to such media attention as exemplified in the panel discussion, the message finally reached MoESC that all was not well as far as the teaching of science and mathematics was concerned. This section gives a brief background to the origin of the SEITT project, which is the context in which the RT study takes place.

At this stage it is necessary to go back to the original letter that the then Ministry of Education wrote to the University of Zimbabwe (UZ) in 1992. The letter was directed to the Department of Science and Mathematics Education (DSME) in seeking help to establish an in-service programme for A-level science and mathematics teachers. In the letter the ministry acknowledges, *"The quality of delivery of the A-level science curriculum was adversely affected with the result that scientific concepts and processes are superficially covered*". This problem, according to the letter, is "*compounded by the shortage of adequately trained teachers who possess a repertoire of skills critical to effective teaching*". In the same letter the Ministry of Education was formally approaching DSME "… *for assistance in soliciting funds, both locally and internationally, for a staff development programme of teachers of science, including workshops and development of science teaching materials to expedite the teaching of A-level science"* (Ministry of Education[3], 1992).

[3] In 1992, The Ministry of Education had not yet incorporated sport and culture, unlike the present MoESC.

As can be seen from the extracts of this letter, a problematic teaching and learning environment is acknowledged. The school system did not have enough equipment and adequately trained teachers to effectively teach the students. The Ministry of Education was in effect asking DSME to put in place and help implement an in-service programme that would improve the teaching skills of teachers as well as provide teaching materials.

To understand what the Ministry meant by poor "quality of delivery of the A-level syllabus", a limited fact finding study by two DSME lecturers was subsequently carried out. The study (Ncube & Engels, 1995) found that the majority of the observed teachers rely on the lecture method of teaching. Students are considered engaged when they respond to a few questions and spend the rest of class time listening to the teacher or taking down notes. The study also found that teachers were very time-conscious in terms of syllabus coverage to the point that they would just mention some concepts, demonstrate how to solve a few problems in that concept, and then move on. It was a typical case of covering the syllabus, more than it was of teaching students.

1.4 THE SEITT PROJECT

DSME responded to the request of the Ministry by establishing the Science Education In-service Teacher Training (SEITT[4]) project. The first funded phase (SEITT I) ended in 1997 and the second phase (SEITT II) started in 1999. There were no major differences between SEITT I and II, hence the acronym SEITT will be used throughout this study report.

The main objective of the SEITT project was, and still is, the improvement of the quality of science[5] and mathematics teaching at A-level. To achieve this rather ambitious objective, DSME members, in consultation with the Ministry in 1994/95, drew up a comprehensive plan of professional development. This plan, known as SEITT, has the following components: training of resource teachers (RTs), establishment and running of science and mathematics centres (SMCs), writing of curriculum materials, networking of teachers, technical support and research. The SEITT strategy involves training RTs through a two-year university diploma

[4] SEITT phase I was funded by NUFFIC (Kool & Hodzi, 1994) and SEITT Phase II was funded by the Royal Netherlands Embassy through its education sector (Mushayikwa, Tambo, Chavunduka, Mtetwa & Mukono, 1998).

[5] Science at A-level represents the individual subjects of Biology, Chemistry, and Physics.

programme. After graduation, RTs are expected to run the entire provincial professional development programme for their peers, supported by lecturers from DSME, University of Zimbabwe.

1.5 AIM OF THE STUDY

The aim of this study was to evaluate the RT implementation of the SEITT approach, including the RT preparation and support. Also important in this study was how RT perceptions of their education and roles influenced the extent to which SEITT was implemented at the provincial level. The study as a whole has been guided by the following question:

> *How successful was the SEITT strategy in preparing and supporting resource teachers for their facilitative role?*

The objectives of the RT education programme were used as a baseline for the determination of intended RT roles and projected capabilities. These projected roles and capabilities, together with the aims and objectives of SEITT as defined in the decentralised project document, were used to serve as criteria for judging observed roles, activities, and the extent of SEITT's implementation by RTs.

The outcomes of the evaluation study are valuable in a number of ways. As an evaluation of the SEITT strategy of using RTs for inservice education and training, it will contribute to knowledge concerning this element in the design of professional development delivery strategies. As an evaluation of the practices of RTs, its importance is twofold. Firstly, it offers information that is useful in improving the training and support provided to RTs. Secondly, it provides information that can be used to adjust the implementation practices of RTs in order to increase their effectiveness. As a local knowledge base, it should provide MoESC with background knowledge that is useful in forming policies that are facilitative to the professional development environment.

1.6 RESEARCH COMPONENTS

The evaluation study was initiated at a time when the SEITT programme was already running. Four questions immediately presented themselves. The first

question was how consistent the SEITT programme was with the research findings on what constitutes effective professional development. Answering this question demands a reconstruction study of the SEITT approach using research literature on effective professional development practices. The first component of this study therefore was to perform an analysis of the SEITT approach from the perspective of research literature.

After their training through the diploma programme, it was the expectation of all stakeholders that RTs understood their roles and were ready to implement the SEITT approach. It was also the general understanding that all stakeholders understood what RTs were supposed to do. For this study, it was important to know the starting point of both RTs and stakeholders in order to facilitate the explanations of outcomes. The second question, therefore, referred to the understanding of the roles and functions of RTs by both RTs and stakeholders. This was done through a baseline study.

The third question had to do with the actual implementation of the various components of the SEITT approach: how was this approach being implemented, and to what results? This third component involved several rounds of evaluation over a period of three years. The elongated period of data collection was necessary for two reasons. First, it helped establish implementation patterns of the SEITT approach throughout the implementation timeline. Second, it made transparent how RTs handled issues of change, since the programme was aiming at influencing teaching and learning practices, skills, and beliefs. Data obtained had also to take this background into consideration in order to facilitate useful conclusions.

These studies lead to conclusions about the possible ways to improve the professional development programme. Among these conclusions was the need to provide teachers with more guidance in implementing teaching for understanding. Although the SEITT approach planned to develop materials, this was taking too long with respect to immediate teacher needs. The fact that teachers wanted to go beyond modelling in workshop environments into real classroom situations suggests that they appreciated the ideas and skills obtained and wanted help with putting these into practice. This was a promising indicator of the potential for SEITT to bring about some change to classroom practice. It was therefore seen as promising to develop a sample set of materials to be tried out by a few teachers in their classrooms. The materials were going to emphasise constructivist, learner-centred teaching as well as provide the

teacher with ample help in putting the lessons together. The design, development, trial, and evaluation of the consequent practice when these "COntextualised LEarner Centred Teaching (COLECT)" materials were used, constituted the fourth component to this study. This design, implementation, and evaluation project embedded in this evaluation study was nicknamed the COLECT study.

1.7 OVERVIEW OF THE FOLLOWING CHAPTERS

Chapter two outlines the contextual framework within which the SEITT approach operated and consequently within which its implementation was evaluated. Areas such as the education history and schooling in Zimbabwe are outlined. The SEITT project and how it was implemented and managed are detailed. The section also presents the objectives of the training of RTs at the University of Zimbabwe (structure of the training programme is found in Appendix A). *Chapter three* is a reconstruction of the SEITT approach based on literature review. It aimed at inquiring the validity of the SEITT approach. The chapter presents the basics of professional development and follows these with a presentation of the principles of professional development. These principles are then used to appraise the SEITT approach, with one component considered at a time. *Chapter four* details the baseline study that was instituted to investigate the perceptions of RTs and all key stakeholders with regards to RT understanding of their roles and practice. *Chapter five* discusses the outcomes of the evaluation of RT practice and draws conclusions. A follow up study that arose as a result of the outcomes of the evaluation study of chapter four is reported in *Chapter six*. This chapter reports on the COLECT study. It details the design, implementation, and evaluation of a small materials package that was meant to assess how teachers and students would react to learner-centred teaching and learning. Finally, *chapter seven* discusses the findings of the evaluation study as a whole and deduces from it some pertinent theoretical as well as practical implications.

- 2 -

CONTEXT OF THE STUDY

Chapter two provides the context within which the RT study is embedded. Section 2.1 offers a brief history of Zimbabwe in terms of its colonial past with respect to African education. The sections of the Ministry of Education Sport and Culture that have a direct bearing on the operations of SEITT are described in section 2.2. The following section, 2.3, outlines the operations of the Department of Science and Mathematics Education at the University of Zimbabwe. This is the home of SEITT where some of the aspects of the SEITT approach are implemented. The main contextual factor, the SEITT project, is described in section 2.4. Section 2.5 presents contextual factors that have influenced some of the design decisions of the SEITT approach. The chapter ends with some concluding remarks on the process of SEITT (section 2.6).

2.1 ZIMBABWE

The first part of this section is a brief review of the troubled transition from Rhodesia to Zimbabwe. The section is important in that it describes the foundation of the problems that bedevilled Zimbabwe at the time of independence. An attempt to solve these problems has resulted in the poor present condition of teaching and learning in Zimbabwean schools.

2.1.1 GENERAL INFORMATION

Zimbabwe, as an independent republic, was born in April 1980. Before then it was Rhodesia since 1850, became Southern Rhodesia during the federation with Nyasaland, and then reverted back to Rhodesia in 1965 when the European community in Zimbabwe declared independence from Britain. This independence, however, simply meant a shift from Britain's role as colonial master, to the local Europeans. After a protracted war of liberation, with much destruction of infrastructure, including schools and hospitals, and a negotiated settlement between the African nationalists and Britain, majority rule prevailed and Zimbabwe came into being. The war of liberation, among other objectives, had been fought to bring about universal suffrage, an equitable distribution of wealth, education and health provision.

Situated in Southern Africa, Zimbabwe (Figure 2.1) is a landlocked country surrounded by Zambia, Mozambique, South Africa, and Botswana. The capital city is Harare.

Figure 2.1
Map of Zimbabwe

Source: CIA world factbook, 2001

Zimbabwe has a population of about 13 million. Of this population, 98% are indigenous blacks. Zimbabwe has a literacy rate of 91%, with age 15 and over being able to read and write in English. Three official languages exist—English, Shona, and Ndebele— with English functioning as the official language of transactions and as the medium of instruction from grade three upwards. English is a second language for all indigenous Zimbabweans.

2.1.2 EDUCATIONAL HISTORY

The ministry of education back when the country was Rhodesia was made up of two departments—African and European education. Education for Europeans was

free and compulsory whilst it was neither free nor compulsory for Africans. For Africans, the curriculum was limited and provided a minimal skills base.

Soon after UDI, secondary schooling for Africans was reorganised into a two-tier system. The F1 secondary schools followed an academic curriculum, which would allow a few graduates access to sixth form and subsequently university and teacher training colleges. The F2 secondary schools, on the other hand, were created for "the less able" according to the council that created this system (Zvobgo, 1994). As such, a stigma was attached to the F2 system. Students, parents, and teachers were infuriated by this development. F2 students followed a vocational curriculum, which was meant to prepare students for employment in industry. According to Zvobgo (1994), only 12.5% of primary school graduates accessed F1 secondary schools and 37.5% accessed F2 schools. A strict examination system was put in place at every stage of the African system to eliminate as many students from the education system as possible as well as to act as a selection criterion for the F1 and F2 systems.

The Secretary for Education report of 1993 states that the war of liberation was fought, in part, to eliminate these inequalities. The attainment of independence brought in a number of changes to the school system. The F2 system was abolished and only one system of secondary schooling, along the lines of the F1 system, remained. Second, all schooling was made free up to grade seven. The grade seven and form two examinations lost their traditional function as screening mechanisms now that students could automatically proceed to forms one and three, respectively, regardless of their performance in the respective examinations. Third, informal education in the form of night school and study groups was expanded to service unschooled adults and the majority of cadres who had missed out on formal schooling whilst advancing the cause of independence. As a result, primary school enrolments increased from 819,000 in 1979 to 2,229,000 in 1985 (Chung, 1988). During the same period, secondary school enrolments increased from 79,000 to approximately half a million.

The post independence education programme was a success given that it offered basic reading, writing, and arithmetic skills to the majority of the population. From this success, however, came a number of challenges. The phenomenal increases in school enrolments ushered in a new set of problems. First, because there weren't enough trained teachers to handle these numbers in both primary and secondary schools, a massive employment of untrained teachers ensued (Zesaguli, 1994).

Expatriate staff mainly from the United States, United Kingdom, and the Netherlands, were also engaged in large numbers. Teacher turnover at schools was high during these years. The 90s saw a stabilisation of the teaching force, with a diminishing use of untrained teachers in favour of those who had been trained through various methods. Among these methods were the fast track programmes at teacher training colleges for trainees who had relevant passes at A-level. The Cuba teacher-training programme for the training of science and mathematics teachers was the other. The same period witnessed an upsurge of "content" teachers from the University of Zimbabwe.

Second, this happened in the context of the same infrastructure that existed before independence, thus leading to a serious strain on resources and buildings. 'Hot seating' [1] was therefore introduced in almost all high-density secondary schools. Removal of screening at grade seven and form two, coupled with a literal shortening of the school day in 'hot seating' schools, exacerbated by an increase in class sizes from an average of 30 to 45 pupils, affected the quality of teaching and learning. More schools were, however, built later to ease the pressure on the burdened infrastructure, but these new schools experienced serious problems due to insufficient provision of laboratory equipment and materials for science teaching. Projects such as the ZIMSCI (Zimbabwe Science Curriculum Initiative[2]) were developed to assist untrained teachers in handling science lessons (these were somewhat teacher-proof science kits).

The 90s also witnessed the birth of a number of professional development efforts meant to improve administration and teaching staff in schools. The Better Schools Programme (BSP) and its successor, Better Schools Programme Zimbabwe (BSPZ), was initiated by MoESC to improve the administration of schools through in-service training of heads of schools, heads of departments, school bursars, and other administrative staff at the primary and secondary school level. Its successor, the BSPZ, addresses the quality of teaching and materials provision issues, but mostly at the primary school level. Better Environmental Science Teaching (BEST) and Quality Education in Science Teaching (QUEST) addressed teaching skills at primary and secondary school science teaching, respectively. SEITT is among this family of in-service programmes, but it is geared toward addressing quality-teaching issues at A-level science and mathematics subjects.

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1 A shift system where one school starts early in the morning and goes until noon and an afternoon school that uses the same buildings in the afternoon.

2 Teacher-proof materials requiring a technicist approach to teaching (Hungwe, 1994).

2.2 ORGANISATION OF MOESC

2.2.1 MOESC STRUCTURES FOR CURRICULUM IMPLEMENTATION

This section looks only at those aspects of MoESC that are relevant for the implementation of the SEITT approach for professional development.

The head office of MoESC is located in Harare. At operational level MoESC is headed by a secretary for education who has under him a team of directors and deputy directors. The director of schools in particular is assigned to see to the implementation of SEITT at the national level as well as the conduit through which SEITT at the University of Zimbabwe communicates with provincial offices of MoESC. The schools division is responsible for maintaining and improving the quality of education. To this effect, the division of schools has been running the Better Schools Project-Zimbabwe (BSPZ). Through this programme a considerable number of administrators, heads of schools, Education officers (EOs), and mostly primary school teachers have been in-serviced. For MoESC organisation, SEITT falls under BSPZ, although these two professional development programmes are administered separately at the budgetary and implementation level.

The Curriculum Development Unit (CDU) has fulfilled the traditional role of curriculum production, curriculum revision, and production of curriculum materials. This role has mostly been fulfilled with respect to primary school and O-level curricula and materials. A-level curricula have, up until December 2000, been imported from the United Kingdom (UK). The UK has since handed over this responsibility to Zimbabwe, and at the moment the Zimbabwe Schools Examinations Council (ZIMSEC) is responsible for production and examination of the science and mathematics curricula. Although SEITT engages in curriculum material writing in order to influence the teaching and learning of science and mathematics, the involvement of CDU and ZIMSEC is not clear.

2.2.2 PROVINCIAL ORGANISATION OF MOESC AND THE SCHOOL SYSTEM

MoESC is represented in each of the country's nine provinces by a provincial office, which is headed by a provincial director. The provincial director, with advice from his EOs, is able to allocate the provincial education vote to activities that are considered educationally sound in terms of improvement of student school experiences. As such, the provincial director can allocate funds to professional development activities or related issues even if such a vote does not exist at national level.

Under the provincial director is a team of education officers, one for each of the subjects taught at secondary level. The science EO (as well as the mathematics EO) has ascribed to him/her a number of roles including supervising the teaching of science in the schools, monitoring the pool of science teachers in the province with respect to numbers, quality, and qualifications, and recommending teachers for tenure. The EO was traditionally in charge of organising and running in-service workshops for teachers in areas that were deemed by the province (or nation) as necessary in the course of teaching of science. A recent addition has been the role of evaluating teachers for performance appraisal purposes. This latter role could influence the way EOs now interact with teachers. In the past, a collegial relationship was possible since the EO could easily be seen as an advisor. The performance appraisal role, however, has the effect of adding distance between EOs and teachers since EOs now judge teacher work where the judgement is used to make decisions on matters that directly affect teacher welfare and career prospects.

Third in command, if the provincial power structure is taken as a linear entity, is the head of school (the principal). The head of school's influence on activities teachers engage in during working hours cannot be overemphasised. The philosophy and beliefs of the school head strongly influence what can be done in their schools. This includes the trying out of innovations, whether formulated outside or within the school. If the head is not disposed to curriculum experimentation, then those teachers who try to implement new innovations experience difficulties.

Each province is in charge of a number of schools. The national outlook, in terms of the numbers of high schools as of March 2001, is shown in Table 2.1. The educational provinces correspond with the political provinces as shown in Figure 2.1.

Table 2.1
Education provinces and sixth form schools in each province

Province	**Harare**	**Manica land**	**Mas-vingo**	**Mid-lands**	**Mash. Central**	**Mash. East**	**Mash. West**	**Mat. North**	**Mat. South**
No. of schools	35	22	14	21	9	19	15	24	13

Source: MoESC statistics sheet, March 2001.

2.2.3 SCHOOLING IN ZIMBABWE

Schooling in Zimbabwe is arranged in the form 7-4-2 with respect to primary, secondary (O-level), and A-level. The Zimbabwe Junior Certificate (ZJC), which

used to split the four O-level years (into two ZJC and two O-level), has slowly lost significance and hence can be ignored.

Coming at the end of each of the three stages above is a national examination. Since 1980, grade seven examinations have played a diminishing role as a selection tool for entry into secondary school. Government secondary schools have a non-discrimination policy with regards to grade seven passes whilst the majority of private schools will only accept students with the best passes at grade seven.

The quality of student O-level results is used to determine whether or not students can access conventional schooling to study at A-level. The O-level results are also used as an entry qualification to some tertiary institutions such as polytechnics. Many employers also use them to decide on an individual's employability. Schools that pass more of their O-level graduates with quality grades tend to be highly regarded by society. All secondary schools therefore strive to produce the largest pass rate at O-level, and not only that, the largest number of students with quality (A-C) grades.

A secondary school that incorporates two years beyond O-level where students study for A-level is called a high school or sixth form school. High schools, whether government or privately run, are highly selective with respect to studies at A-level. Only the best O-level candidates (best in terms of O-level exam grades) are given a chance to proceed to A-level in the formal system. At the end of the two high school years, students write external examinations (which used to be set and marked by the University of Cambridge Local Examinations Syndicate (UCLES) of the UK, but have, since the beginning of 2001, been localised and are managed by ZIMSEC). A-level candidates who obtain a minimum grade of C in all three subjects studied at A-level have a chance of enrolling at Zimbabwean Universities. The need to get as many A-level candidates to pass their examinations and proceed to university places considerable pressure on A-level teachers. The pressure is even greater when society starts to demand not only pass grades but quality pass grades at schools.

Every school in Zimbabwe has a parent association—referred to as a School Development Association (SDA) for government-funded schools or School Development Committee (SDC) for privately funded schools. SDAs/SDCs, employers, and tertiary institutions are the most visible stakeholders demanding school accountability in Zimbabwe. Vignette #3 of section 1.1 hinted at the pressure originating from employers and tertiary institutions.

SDAs and SDCs are becoming increasingly powerful influences within the school system due to the financial power they derive from the huge amounts of money collected from parents in the form of development levies. Most infrastructural development at government schools—building new classrooms, security, purchasing school buses, and maintaining school grounds and library facilities—is done by SDAs/SDCs. The purpose of these organisations is to improve the learning environment of their members' children. The programmes of SDAs are based on the needs of individual schools as defined by teachers through their principals, who have an automatic seat in the SDA committee. By virtue of their financial authority and the composition of their members, these bodies have every right to demand high quality teaching within the schools they represent. They assess quality in education, however, in terms of the percentage of pass grades.

2.3 DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION (DSME) AND PROFESSIONAL DEVELOPMENT

MISSION AND PROGRAMMES OF DSME

The mission of DSME is to provide the Zimbabwe school system with quality science and mathematics teachers. To this end DSME runs Bachelor of Education (BEd) programmes in science and mathematics. Through the BEd programme, the subject content knowledge of teachers is improved enough to enable BEd holders to teach science and mathematics up to A-level. DSME also administers the science and mathematics components of the Post-Graduate Diploma in Education (PGDE). Through the PGDE, holders of science degrees such as BSc are trained in education and certificated as teachers. DSME also offers the Master of Science in Education degree. DSME was therefore the natural home of the SEITT project.

STAFFING FOR THE DSME SEITT CORE STAFF

Interest in lecturer profiles will only be limited to those individuals who have direct input in SEITT. At the inception of SEITT, the programme operated with four local staff and one expatriate. The Free University of Amsterdam seconded this individual to DSME. He had previously taken part in a number of in-service programmes in Southern Africa, and thus had gained a good background to the general problems of teaching in this region. The co-ordinator of SEITT at that time was a lecturer who had previously taught at A-level for many years before joining DSME and after attaining a Master of Arts in Teaching from a US university. The

second Zimbabwean staff member had taught at A-level before going to England where he graduated with a MPhil. specializing in the professional development of teachers. The third lecturer, a woman, also taught chemistry at A-level. She held a MSc in chemistry while the fourth member held a PhD in mathematics education from the US. Towards the end of 1998, the four SEITT staff members were joined by another full time lecturer who had just completed a MPhil from an Australian University and who had two years of A-level teaching experience. All the local SEITT staff members were, therefore, familiar with the Zimbabwean A-level teaching environment. Also motivating their involvement in SEITT was the fact that SEITT fit in the community service third of their employment contract.

TRAINING OF DSME CORE STAFF IN PREPARATION FOR PROFESSIONAL DEVELOPMENT DUTIES

Prior to taking the programme to schools, DSME made sure the five members were trained in professional development methodologies. This was achieved through study visits to the Netherlands and the United Kingdom. This capacity building has continued throughout the programme, with more recent visits to the Netherlands by the SEITT technician who was trained in the basics of computer maintenance and software management. The technician's training prepared him for improved service within the technical support component of the SEITT approach. Even the SEITT secretary was earmarked for training to enhance her skills, thus improving programme management.

2.4 THE SEITT PROJECT

The motivation for setting up SEITT has been explained directly in section 1.3 and the objectives of SEITT have been stated in section 1.4. The state of affairs in Zimbabwean secondary schools, which has been discussed in the opening sections, has been added to these sections. The RT study is defined within the SEITT project. An exposition of SEITT will therefore put the RT study in proper perspective.

The following subsections provide information about the SEITT project as a whole and the SEITT approach in particular. The six components of the SEITT approach to professional development, as introduced in section 1.4, will be expounded.

2.4.1 OVERALL PROGRAMME

Figure 2.2 illustrates the essential features of the SEITT project. The intersection of the ellipses signifies the interrelationships between the various components of the

SEITT approach, DSME, and BSPZ. The degree of intersection, however, has no mathematical significance. Figure 2.2 shows that DSME is connected directly to the provinces via research and technical support. On cascading of training, DSME is connected directly through the education of resource teachers. SMCs and resource teachers constitute the connection between all the components of the SEITT approach and DSME.

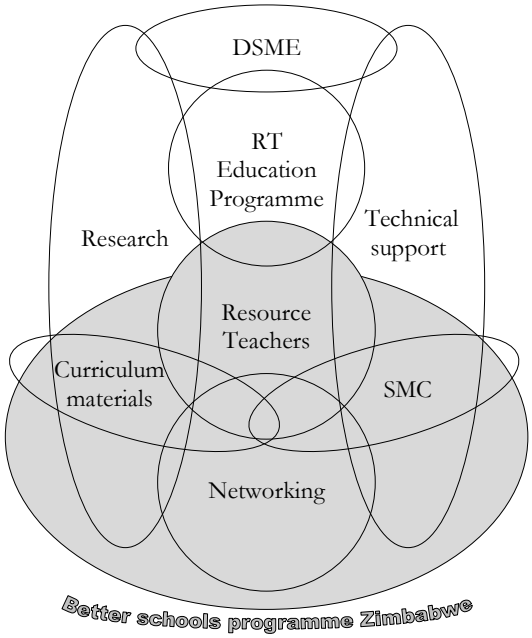


Figure 2.2
SEITT programme: the relationship between the SEITT approach, DSME, and BSPZ programme

AIMS AND OBJECTIVES OF THE SEITT PROJECT

The following were the aims of the SEITT project:

- Improve the quality of teaching of science and mathematics at A-level
- Establish a permanent in-service wing at DSME
- Establish, at provincial level, a self sustaining in-service programme run by a pool of trained RTs.

The short-term objectives of SEITT were:

- Establish a diploma training programme for training RTs
- Establish and equip SMCs
- Run subject content and pedagogical workshops
- Write curriculum materials and
- Establish teacher networks and research teams.

The order in which SEITT aimed at implementing the training programme is shown in Figure 2.3.

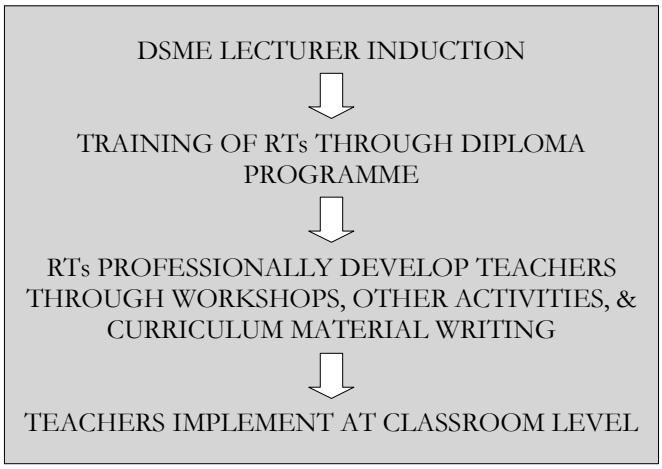


Figure 2.3
Cascading in SEITT

At training level, the SEITT strategy employs the cascade model. The levels of cascade are illustrated in Figure 2.3. Cascading was chosen because a big number of teachers could be trained within a relatively short time (McDevitt, 1998; Raina & Mahashrawi, 1998) when a small number had been trained initially. Fidelity of training, however, is dependent on the existence of a training package that those lower down can continue to refer to (Dove, 1986; Ellinger, Watkins & Barnas, 1999).

2.4.2 THE SEITT APPROACH

In this study, the six components of the SEITT strategy are referred to as the SEITT approach (see also de Feiter & Ncube, 1999). These components, first introduced in 1.4, are described below.

I RESOURCE TEACHERS

SEITT was designed to be run by and for teachers, and to this effect, the concept of RT was developed. RTs in the SEITT approach are the trainers of teachers. The objective of RTs as a whole is to facilitate the exchange of ideas among teachers. Where the requisite ideas do not exist within the teacher body, RTs introduce such ideas and facilitate the necessary transfer and assimilation of such ideas by teachers. A variety of roles, which RTs were anticipated to play in varying degrees, were:

- manage SMCs;
- organise workshops for teachers on various content areas and for skills transfer (workshops were to be facilitated by specialists from outside the school system, i.e. scientists and science educators);
- initiate and lead curriculum materials writing teams;
- co-ordinate various teacher network platforms such as production of magazines and newsletters, internet and e-mail interactions, and subject group meetings;
- initiate and conduct classroom based research as well as take part in more comprehensive research projects undertaken by SEITT co-ordinators.

To be able to perform such an array of difficult roles, an RT had to have matching qualities and be provided with relevant education. The literature calls for the preparation and support of such leadership through formal education (Griffin, 1995; Ovando, 1996; Sherril, 1999). DSME made this possible through the institution of a tailor made post graduate diploma programme that had a heavy bias on in-service methodologies. Box 2.1 lists the objectives of the RT training programme. The general structure and content of the diploma programme is given in Appendix A.

Box 2.1
Objectives of the Diploma Programme

The Diploma programme in general is intended to develop resource teachers who:

1. are functional inset facilitators of A-level science and mathematics teachers.
2. should be able to actively participate in the management structure of the SMC in their province.
3. should be able to co-ordinate in-service activities in SMC in their particular subject discipline.
4. should be able to provide leadership to other teachers in matters pertaining to professional development.
5. should be able to initiate, plan, execute, and evaluate a workshop programme for fellow teachers.
6. are able to identify and address the instructional needs of teachers.
7. are able to source appropriate materials and human resources to address teacher needs.
8. are able to conduct research.
9. are able to design and produce contextualised curriculum materials in their subject areas aimed at effective teaching and meaningful learning.
10. possess a repertoire of skills in their subject areas and are able to transfer these skills to other teachers in workshop environments.
11. are familiar with the use of information technology both for e-mail and internet sourcing of teaching materials and are able to train their peers in the same.

Source: Post-graduate Diploma in Science Education (INSET) course syllabus.

II SCIENCE AND MATHEMATICS CENTRES (SMCS)

A typical SMC in the SEITT programme is housed within what would have been a preparation room in a laboratory complex in the science department of a high school. At one corner is a desk where the resident and/or attendant RT sits. A laboratory assistant and the head of department are likely to have access to the room as well. The following inventory will also be found within the same room: a photocopier and overhead projector, two computers connected to Internet and a printer, and a considerable amount of textbook material in all the science and mathematics subjects.

Various settings are found within different SMCs, but most comply with the criteria set up by SEITT core staff and MoESC. There are three variations to the SMC described above. One SMC host school had accommodation problems and therefore decided to split the housing of the SMC materials within two already occupied rooms. They placed the two SEITT computers in their computer laboratory and the books and photocopier in a corner of the school library. A second model of SMC is similar to the typical model in terms of internal arrangement of equipment and materials, but in this case they are housed in a renovated room detached and independent of both the mathematics and science departments. Another SMC has moved out of the typical model described above into a MoESC office block in the centre of town. This SMC has a number of rooms allocated to it and they have the freedom to allocate rooms to different components of the SMC. The nearest high school to this SMC is 750m from the SMC site. A hired attendant sees to the general administration of the SMC in the morning and RT's take turns visiting teachers in the afternoons.

Prior to the establishment of SMCs, DSME engaged MoESC by means of a workshop for senior management of the two institutions. The Secretary for education, all the provincial directors of education, and all science and mathematics EOs were involved. This very important stakeholder meeting discussed and resolved the following issues: criteria for choosing SMC host schools; equipment for SMCs; the possible functions of SMCs; the management committee concept; and future funding of the SEITT project. After two days of discussions and brainstorming, the meeting came up with a document that was to be used as guide in the absence of a clearly articulated policy on INSET within MoESC. At the close of the meeting the secretary directed his provincial directors to speedily identify a school in their province that would host the SMC. Subsequently, an SMC was set up in every province, including two in Harare.

III CURRICULUM MATERIAL WRITING

This section focuses at the component of SEITT that sought to develop materials for use by teachers and students. Two parallel approaches to curriculum materials writing were adopted. The first was provincial-based and led by RTs as a post PCK workshop activity. In this activity, the subject RT formed a writing group with a mandate to translate workshop discussions into teaching materials. These materials were to reflect workshop consensus on the best teaching and learning strategies for a particular topic, with all strategies adopted being student-centred and constructivist in orientation. The resultant materials were mostly to be in the form of a series of lesson plans, or subject content handouts prepared by the writing team. The second approach was national. Here subject groups, with a national character, produced subject modules, but also drew from teaching ideas discussed at provincial level. The materials offer a practical example of how teachers are expected to teach for understanding. Materials incorporate procedural specifications designed to facilitate planning and teaching using the materials. Initially, and to ensure use of the materials, topics identified as problematic to teach by teachers during context analysis research became the themes for materials writing. The topics were drawn straight from the A-level syllabus, and content covered by the materials was aligned to the demands of the A-level syllabus.

There are four basic objectives to materials writing in the SEITT context. All four objectives aimed at addressing materials provision and teaching for understanding. The curriculum materials were meant to:

- 'contextualise' science and mathematics concepts. This enabled students to see science in their environment and thus enable them to bring in their experiences in learning science and mathematics concepts;
- direct teachers to local resources that could be used to teach the A-level syllabus. With respect to resources, teachers are directed as to where they can easily obtain apparatus, or how they can substitute a difficult to get piece of apparatus or material, and suggestions for locations for field visits;
- simplify text language to ensure second language readers can understand science;
- promote learner centred approaches to teaching and learning.

In doing so, however, a number of teacher concerns had to be taken into account to ensure the materials would be used. The first of those concerns was time. Teachers have this belief that student-centred teaching is time consuming to such a point that finishing the syllabus in time for final examinations becomes a problem. The second

concern has to do with the depth of content coverage. Whilst the materials seek to 'contextualise' content, the focus on concepts needs to be maintained otherwise students focus on the context itself and fail to see the concept. Third is the belief by teachers that real science cannot be realistically taught using local substitutes either in the form of materials/apparatus or teacher written materials.

THE MATERIALS WRITING PROCESSES

At provincial level, writing was meant to be done by classroom teachers guided by RTs. It was meant to be purely a grassroots run activity. At national level, however, careful consideration of the composition of writing teams was made. Issues of ownership and subject content validity had to be seriously considered. As such, composition of national writers had to be carefully considered. RTs constituted the core of curriculum material writers. EOs took part in some of the groups. The RT subject groups, which are national in character, were co-ordinated by an SEITT co-ordinator from DSME. The RTs did most of the writing. The co-ordinator chaired the subject writing group and supervised the writing process. The co-ordinator also edited the materials and made sure writers stayed within prescribed parameters. The co-ordinator also facilitated the reproduction and distribution of draft modules to the team during writing.

After the teaching unit had been written (both teacher and student guides), the team of writers organised a meeting where each writer demonstrated all the activities that involve apparatus, especially where lots of substitution for local materials had been done. The next stage involved each writer organising a subject workshop in their province where the draft modules were discussed, some skills demonstrated, and teachers given a chance to take the draft modules to their schools for further scrutiny. Teachers at this stage were free to suggest alternative activities. The draft also went to a content reviewer during this time. After a set time, the critiques were collected, and where the teacher's ideas were considered better than those of the writers, their suggestions were incorporated. This leads to the second draft. This draft was produced in as complete and attractive a manner as possible.

IV NETWORKING

The component of SEITT that networks teachers is called the Zimbabwe Science Network (ZimSciNet). ZimSciNet has been promoting communication among teachers as a way of removing teachers from their isolation. The SEITT strategy assumes that change will occur if there is a collective effort by teachers, and

therefore teachers must be able to discuss ideas and share problems with other teachers. The chances are that somewhere somehow somebody has had a similar experience and is prepared to share insights with someone. Such is the thinking behind the networking of teachers. SEITT has tried to open a number of communication channels among teachers of science and mathematics. Three channels had been opened during the tenure of this study. Two traditional methods and a high tech method of communication will be described below.

During the first year of operation, SEITT facilitated two national meetings of the Zimbabwe Association of Science Educators (ZIMASE). ZIMASE has been in existence since the 70s but over the years has suffered from poor funding and lack of seriousness among its leadership. The primary objective of ZIMASE has always been to facilitate periodic meetings of science teachers at district, provincial, and national level in order to discuss the various issues related to the teaching of science. ZIMASE had, before the advent of SEITT, published a periodical which was a compilation of articles written by science teachers throughout the country. The ZIMASE structures were seen to fit well with the vision of SEITT, hence it was conceived as possible to finance its resuscitation. Attempts to resuscitate a similar mathematics organisation had not yet taken off. Networking also aimed at periodic publication of a SEITT magazine and newsletter.

For the high technology method of networking, all SMCs had Internet installed and financed directly by the SEITT project. The Internet facilitated networking in that teachers could access teaching ideas posted by other teachers throughout the world. Through the Internet, individual RTs could also open personalised accounts through free e-mail providers such as Yahoo or Hotmail. E-mail accounts for each SMC were also installed to make it easier for provincial groups to send each other information that could be accessed directly by all RTs. RTs could also access materials through their subject DSME co-ordinator by just sending an e-mail request.

V TECHNICAL SUPPORT

Technical support, according to SEITT, was two-pronged. There was support associated with academic subject matter and that associated with provision of assistance on technical matters. These two types of assistance are briefly considered below.

The first, though hardly recognisable as technical, is academic support. Through this, specialists in biology, chemistry, physics, and mathematics drawn from

Zimbabwe's universities, industry, and teacher training colleges were made accessible to the provincial professional development programmes. To facilitate access of these specialists, a directory of technical and subject experts within each province who could be invited to address teachers in a workshop situation on an identified process or problem was to be compiled. Through this, advances in scientific knowledge could continue to filter directly to the teachers.

The second aspect involved technical support in its literal sense. SEITT core DSME staff through its provincial co-ordinators would be the main providers of technical support. Such support would include advising RTs on how best to implement sections of the provincial programme. DSME also had a trained technician who could be called upon to solve technical problems should they arise, especially problems associated with SMC equipment. Such technical support would run along the lines of a help desk system.

VI INTEGRATED RESEARCH AND EVALUATION

This component was designed to study the efficacy of each of the various aspects of the SEITT strategy and provide feedback to the different components of the programme. Research was meant to provide information to improve every aspect of SEITT. RTs and classroom teachers would be encouraged to do research, as this has been found to assist teachers in becoming change agents in schools (Glesne, 1991; Kemmis & Mctaggart, 1982; Noffke, 1992; Zeichner, 1987;). This very study was part of SEITT strategy for evaluating the SEITT programme. Every activity of SEITT had to have a research component. Through such research, SEITT would be equipped with data that could be used to continually improve and refine its processes.

Towards the end of 2002, thematic research groups had been formed to spearhead research in the various components of SEITT. The purpose of such research was to assess outcomes and glean for new knowledge. Each thematic research group aimed at publishing their research findings as well as presenting papers at provincial conferences such as SAARMSTE[3]. SEITT was so keen on research that it even made a budgetary provision to support formation and nurturing of a Zimbabwean chapter of SAARMSTE and encouraged teachers to become members.

[3] Southern African Association of Research in Mathematics, Science and Technology Education.

2.4.3 MOESC IN RELATION TO SEITT

Figure 2.4 provides a relationship between the Ministry of Education, Sport, and Culture (MoESC), which is the host ministry for the SEITT programme and the UZ, which is the engineer and co-ordinator of the SEITT programme. In each of the sets illustrated in the diagram, only those parts relevant to SEITT have been included. The nest of ellipses to the left shows the different levels of MoESC that are directly involved in SEITT activities, whilst those to the right show organs of UZ that participate in SEITT. Between the two sets of ellipses is a management structure of the SEITT programme as a whole. The personnel input of the two bodies to the management structures of SEITT is also shown.

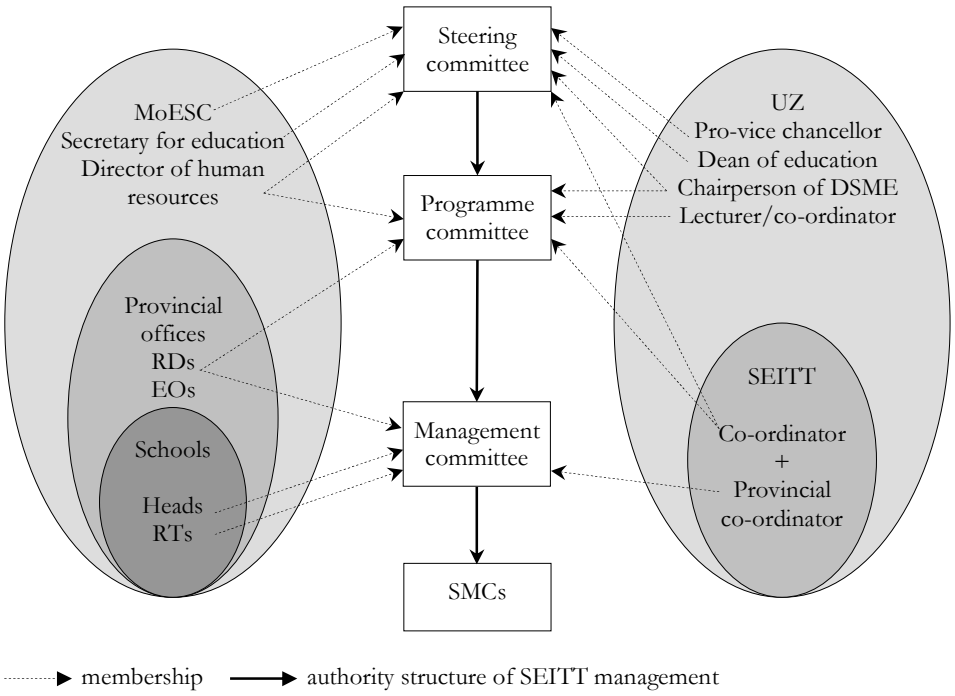


Figure 2.4
Context structure of the SEITT programme

The functions of the different committees will be outlined in 2.4.4.

2.4.4 MANAGEMENT STRUCTURES OF THE SEITT PROGRAMME

I The steering committee

The steering committee drew its membership from both MoESC and the University of Zimbabwe as shown in figure 2.4. A representative of the Royal Netherlands Embassy education sector was sometimes invited to steering committee meetings if

funding issues or the need to make major changes to the operational plan were on the agenda. This high-profile body met twice a year and discussed policy issues pertaining to implementation of the SEITT programme. The SEITT co-ordinator acted as secretary for the steering committee.

II The programme committee

The programme committee drew its membership as shown in Figure 2.4. Its main function was to further discuss policy issues in relation to the implementation of provincial in-service plans. The committee also received and discussed provincial progress reports in relation to annual action plans as discussed and approved at the annual national management committees workshop. This committee served as a national monitoring tool for the SEITT programme. Where implementation faced problems, this committee offered possible solutions and even organised visits by the SEITT national co-ordinator and the MoESC director to offer on site advice.

III Management Committee

Every SMC has a management committee (MC) constituted as shown in Figure 2.4. Two heads of schools, one being the head of the SMC host school and the other being a local representative of NASH[4]. The other members are two EOs, four RTs, one SDA representative, and one technician. MCs plan in-service programmes within their provinces and facilitate implementation of the same provincial programmes. MC plans are carried out within the parameters of the SEITT programme. MCs are the direct link between schools and the community as far as SEITT was concerned. As such, MCs organise annual general meetings where the SMC's programmes are explained to schools and the community. Through this meeting, MCs present their budgets. MCs raise funds from the local community as well as manage funds allocated to the province by the SEITT programme.

At the beginning of every year, MCs are expected to produce an action plan. This is an outline of all the inset activities that they plan to implement in their provinces during the year. This plan comes complete with estimated dates around which specific activities are scheduled to run. MC draft plans are discussed and finalised at the annual general meeting of SEITT, but only in those years when it is held. MCs also produce biannual reports, documents whose information feeds into programme committee deliberations.

[4] NASH = National Association of Secondary school Heads.

2.5 FACTORS THAT INFLUENCED THE STRUCTURE AND PROCESSES OF THE SEITT APPROACH

This section makes a brief description of how some contextual factors influenced the plan and pace of implementation of the SEITT approach. The influences of MoESC head office, EOs, and heads of schools will be described.

2.5.1 NATIONAL IMPLEMENTATION OF THE SEITT PROGRAMME

When the programme was initially conceived, it was going to be piloted in five out of ten provinces of Zimbabwe (Engels & Ncube, 1995). The piloting phase was, however, rejected by the MoESC which cited as one of its major reasons that the programme would unfairly benefit only part of the country whereas there were no other in-service programmes to cater for the rest of the A-level teachers. They also argued that provincial directors and education officers from provinces that do not have an SMC would find it difficult to support the scheme since the SMC would most likely be inaccessible to their teachers due to distance and hence time and expense (SEITT, 1996). Going national against the planned piloting of SEITT had negative budgetary implications. Where the pilot provinces would have had double the number of resources, only half as much was provided. The number of project staff at the University of Zimbabwe remained the same, which meant supervision of project activities performed by RTs would be affected. Due to personnel constraints, SEITT at some point considered inviting EOs to help supervise as well as evaluate diploma student run workshops. This plan was, however, never implemented since UZ regulations would not have allowed sub-letting of assessment procedures to non-employees of the university. This act alone could have caused the trainee RTs to see education officers not as partners in implementing in-service activities for teachers but as teacher evaluators coming in to spy on their performance.

The countrywide implementation also introduced the problem of distance between the schools and their SMC. It also meant that some RTs would have to wait longer to get feedback on their communication with schools when planning activities at the centre. The impact of these and other factors, yet to be revealed through this study on the implementation of in-service activities by RTs, will be assessed.

2.5.2 THE EDUCATION OFFICERS

Education officers at secondary and high school level are subject specific. The science education officer is in charge of all science subjects at this level. It is the EO's responsibility to make sure that school science departments under their jurisdiction are properly equipped for the effective teaching of science. The EO also sees to it that there is competent staff at each of the schools they supervise. To this end, they carry out periodic school visits to observe the teaching of science by individual teachers—"the inspector" role. They also sit in probationer teacher's lessons and make recommendations for granting tenure. Since it is their responsibility to make sure teachers implement the prescribed curriculum, EOs periodically run workshops to introduce teachers to new syllabi or to disseminate information on curriculum changes. As such, EOs wield considerable and direct authority over teachers.

SEITT had incorporated both the head of school and EO in its management committee. SEITT had also specified that the head of the SMC host school could not chair the MC. Since this body was made up of four RTs, two EOs, one or two heads of school, a member of the parent body, and a technician, by majority, the chances were high that an RT would chair the MC. Indeed in some provinces an RT chaired the MC. This automatically meant that a teacher would call for MC meetings and preside over his or her superiors!

SEITT had also taken the risk of including the EO as a teacher partner and an equal with the RT when it came to dispensing INSET. Furthermore, the RT was trained for INSET work, and this training was backed with a university diploma, which the EO did not have. It was not known how this EO, head of school, and teacher partnership would work on the ground. Some of the RTs were not even heads of departments in their own, and thus had yet another authority figure to contend with. De Feiter, Vonk and van den Akker (1995) refer to this as the power distance factor.

2.5.3 SCHOOL HEADS

The school head, generally the teacher supervisor at school level, allocates duties to teachers as he or she sees fit. Guided by the student teacher ratio, school heads also allocate teaching loads to teachers. As such, teachers generally have a teaching load of 30 to 35 lessons a week in daily timetables that include 8 lessons per day. Over and above this, teachers also supervise sports and run student clubs. The teacher is

therefore a very busy person. Releasing a teacher from the school to take part in any activity outside of his or her school responsibilities requires the school head's approval, who must in turn work out replacements or how to keep the students occupied in the teacher's absence. Besides releasing teachers, the success of curriculum material trials in schools was dependent on the co-operation of school heads. A strong and cordial relationship between SEITT and school heads was therefore necessary in order for the two essential elements of SEITT to proceed smoothly.

2.6 CONCLUSION

The context chapter has raised a considerable number of issues suggesting the origin of problems relating to the quality of teaching and learning. The revolutionary expansion of the school system after independence as opposed to evolutionary change is but one such source. Whilst the need to open up education for a heretofore denied majority is acknowledged, the process that was adopted to bring about equality was radical. Use of untrained teachers who were supported by recipe-like student and teacher guides (ZimSci project) affected the present school system in two ways. First, there was the researched finding that teachers teach the way they were taught (Lortie, 1975; Memser, 1983). Some of the teachers we have now were students then. The system had to deal with deeply rooted beliefs. Secondly, the sixth form student in the 90s was definitely at primary school during the era of untrained teachers. The foundation of education for these children was not properly laid. With time some of these students have become teachers. These are but a few of the fall-out effects which, like disease, are quick to infect but slow to cure.

The staff development programmes such as BSPZ, BEST, and QUEST have provided professional development, especially at primary and secondary school level. But they would need to be co-ordinated to address issues of teaching and learning, as well as deal with other pedagogical issues that SEITT addresses. Such harmonisation of professional development would lead to programmes that complement each other. Prolonged operation of these programs is also essential since they deal with matters of change that are known to take a long time. Prolonged and effective professional development, however, can only function in an environment that is adequately resourced and supported by well articulated, disseminated, and followed professional development policies.

Although the SEITT approach appears to be comprehensive, it will be judged against the literature in chapter three. Chapter five will evaluate its process and assess its products. It is only then that inferences on the potential of the SEITT strategy to solve the quality problem will be made. A number of aspects of SEITT, however, are a cause for concern. The number of DSME provincial co-ordinators (only two of them being full time and the other three having to teach in other programmes at the UZ) makes human power rather thin for this size of programme. The sheer size of the programme, touching on virtually every aspect of teaching, will affect its impact. Going national from the very start might be overwhelming for staff members who were relatively new to professional development. Finally, trying to bring about change to a teaching staff that is as varied, in terms of professional qualifications, as the Zimbabwean A-level teaching force, is a daunting task.

- 3 -

RECONSTRUCTION AND THEORETICAL APPRAISAL OF THE SEITT APPROACH TO PROFESSIONAL DEVELOPMENT

This chapter presents a reconstruction and theoretical appraisal of the SEITT approach to professional development. International literature on professional development is used as a basis for the appraisal. After the introduction (3.1), section 3.2 discusses fundamentals of professional development. The SEITT approach, which is the object of the study, is defined in section 3.3. This is followed by a component-by-component appraisal of the SEITT approach (Section 3.4). Section 3.5 presents conclusions.

3.1 INTRODUCTION

The SEITT project was set up to address the need to improve the teaching of A-level science and mathematics. A strategy to respond to this need had been developed in 1993 (this is referred to as the original SEITT project document). The original SEITT project was a top down model of professional development designed at the university, where university lecturers ran workshops for teachers throughout the country. This plan was never implemented. It was replaced by another plan produced after a decentralisation study had been carried out. This change from the original SEITT project to SEITT I is outlined in Table 3.1. The new plan, referred to as SEITT I, was implemented instead. SEITT I adopted a teacher led professional development strategy that involved resource teachers (RTs) executing professional development programmes for their fellow teachers. SEITT I was the master plan for the entire SEITT project implemented in two phases between 1994 and 2002 (SEITT I, 1994-1998 and SEITT II, 1999 -2002). SEITT II was a consolidation phase of SEITT I aimed at strengthening the structures of SEITT I. In this dissertation, the professional development plan implemented by the SEITT project is referred to as the SEITT approach to professional development, generally shortened to just the SEITT approach.

This chapter aims to carry out a reconstruction and theoretical appraisal study that takes a closer look at choices made in the design of the SEITT approach in light of literature on effective professional development strategies. In so doing, the chapter will address the following question:

> *Was the SEITT approach likely to yield its goals when viewed from international literature on effective professional development?*

The reconstruction and theoretical appraisal was seen as relevant in order to determine whether the design of the SEITT approach was potentially powerful enough to bring about the desired change in teaching practices (Guskey, 2000). It will also facilitate later understanding of the implementation study results.

3.2 FUNDAMENTALS OF PROFESSIONAL DEVELOPMENT

The design of professional development is influenced by the definition of professional development put forth by the designers as well as by the following: learners and learning, teachers and teaching, the nature of content, and the principles of professional development (Loucks-Horsley, Hewson, Love & Stiles, 1998). This subsection elaborates on these influences.

DEFINITION

Several scholars have offered definitions of professional development. For instance, Loucks-Horsley et al. (1998) define professional development as those processes and activities teachers go through that are designed to improve their professional knowledge, skills, and attitudes. Guskey (2000) refers to it as those activities designed to improve professional knowledge, skills, and attitudes of teachers so that their professional practice improves. Whilst these two definitions are specific concerning the types of learning a teacher has to go through, Fullan (2001) defines it more generally. He takes the view that professional development refers to all the learning experiences a teacher undergoes both formally and informally, from pre-service up to retirement. From a collaborative perspective, Bromme and Tillema (1995) conceive professional development as that activity which occurs when teachers and researchers co-ordinate new conceptual frameworks with knowledge grounded in teaching.

Building on these definitions, it can be said that professional development refers to those activities that are arranged for teachers during their careers to improve their competence with regards to subject content, skills, teaching processes, and ways of organising the learning environment. The purpose of these activities is to produce competent classroom practitioners.

LEARNERS AND LEARNING

People have different views of learners. For teachers, these views about learners shape the kind of instruction they provide for their students (Bruner, 1996, Loucks-Horsley et al., 1998). Teachers who are influenced by the behaviourist philosophy (Bloom, 1956; Gagne, 1967) see their students as imitative learners. Students are also viewed as empty containers into which knowledge must be poured. Such teachers will focus on passing skills and knowledge to students through demonstrations and examples. Memorisation of facts becomes an important way of bringing about learning retention. The epistemology of objectivism posits the existence of a reliable body of knowledge about the world which must be passed on to pupils (Johanssen, 1991). This view is closely related to behaviourism.

The other and most current view of learners is grounded in the constructivist philosophy. In this philosophy learning is viewed as a social process in which pupil interactions are viewed as most important. In the constructivist view, the following conceptions (Loucks-Horsley et al., 1998; Putman & Borko, 2000; van den Berg, 1996; Wenger, 1998) are central to learning:

- Pupils bring their preconceptions, ideas, and experiences into the learning environment. Such preconceptions influence subsequent learning.
- Students construct for themselves the meaning of what they learn.
- Students re-examine and restructure their understandings of what they learn as they interact with other students and the teacher through discussions.
- The meaning of the new knowledge is context dependent, hence special considerations of contexts during the teaching process are important.
- Learners are responsible for their learning.

These conceptions of learners and learning have implications for teaching. The next section looks at conceptions of teachers and teaching.

TEACHERS AND TEACHING

The first conception of learning leads to a completely different type of teaching from what is derived from the second. Whilst behaviourism (and objectivism) supports the traditional mode of teaching, namely that teachers see themselves as transmitters of knowledge to empty vessel students in need of being filled with knowledge, constructivism leads to a totally different mode of teaching. Teachers that subscribe to constructivism view themselves as creators of opportunities and incentives that support learning (Borko & Putman, 1996; Loucks-Horsley et al., 1998; von Glasersfeld, 1996) rather than transmitters of pre-packaged bodies of knowledge. Classrooms of such teachers are expected to be learner-centred, with stimulating learning environments characterised by explorations and investigations as well as discussions among students and with the teacher. In this environment the teacher serves as facilitator (Gergen, 1995).

The role of teacher as facilitator, however, assumes that teachers possess solid pedagogical content knowledge (PCK). PCK includes not only knowledge of subject matter but also how to teach that knowledge. As such, teachers are not merely technicians (Barnet & Hodson, 2001), that is experts in putting across other people's ideas, but also have their own professional body of knowledge. Such knowledge enables teachers to prepare appropriate activities, anticipate student behaviour and reactions, and judge the difficulty of concepts in relation to the mental capability of their students (Loucks-Horsley et al., 1998).

Constructivism also requires that teachers be aware that the practice of teaching is complex. This is because knowledge is deep and flexible, students are never the same, and teaching is a non-linear process. Teachers have to repeatedly go through phases of planning, acting, observation, and reflection in response to changing learning environments and in anticipation of new situations. Teachers are therefore constantly required to adjust their approaches in response to changing situations (Barnet & Hodson, 2001). Such flexibility is possible for all teachers, and necessary expert knowledge is gained as teachers share collective wisdom through professional development (Loucks-Horsley et al., 1998).

This knowledge presents two implications for professional development. First, it communicates to the professional developers the same message that it communicates to classrooms teachers, namely that teaching is facilitating experiences out of which students learn. This implies that professional development

experiences, as learning situations, should not come in the form of pre-packaged ideas but should evolve from experience. There should therefore be no conflict between the way professional developers approach professional development and how they expect teachers to teach in the classroom. The second message to professional developers is the need to distinguish between subject specialists and teachers of a particular subject. The problem at hand is how to prepare experiences that help convert that content-rich person into a pedagogical content knowledge specialist. It is the basic challenge in the SEITT approach.

NATURE OF CONTENT

In discussing conceptions of learning, the behaviourist's conception of teaching pre-packaged knowledge was questioned and deemed unsuitable. In constructivism the focus shifted from presentations of pre-packaged knowledge to student constructions and reconstructions of knowledge. In this paradigm, students are expected to abandon flawed conceptions of knowledge as they are confronted with new and real experiences that challenge the conceptions they currently hold. It would thus appear that there is something out there that students are called on to construct (Fensham, Gunstone & White, 1994). Whilst acknowledging the existence of a body of knowledge in science, Bereiter (1994) argues that the purpose of learning science is not for students to build knowledge in the scholarly disciplines, a feat they are incapable of doing (Driver, Asoko, Leach, Mortimer & Scott, 1994), but to reconstruct scientific knowledge in educational settings. In this scenario, scientific knowledge then functions to provide a structure for the construction and reconstruction process in the minds of students (van den Berg, 1996).

By its very nature, knowledge in science is a construction of meaning by scientists. It is not absolute truth. In any case the body of knowledge in science is so large that selecting what constitutes the most worthwhile knowledge becomes problematic. What is then considered practical by constructivists is to emphasize quality of knowledge structures rather than quantity (Rieber, 1993). In constructivist philosophy, therefore, the science curriculum should not concern prescriptions of content but a selection of content areas that provide ample opportunities for students to interact with materials, each other, and the teacher, and through that process learn subject content. The following considerations could be used to filter science content (Nelson, 2001; van den Berg, 1996). The content chosen for a science curriculum should:

- enhance the unique experiences and values of childhood as well as allow for students to bring their pre-conceptions to their educational experiences;
- help students gain in-depth understanding of the concepts in the topic;
- facilitate learning of knowledge and skills that are considered useful from a societal perspective;
- facilitate learning of cutting-edge, state-of-the-art knowledge as well as skills and techniques that facilitate further learning in the scientific discipline.

VIEWS ON PRINCIPLES OF PROFESSIONAL DEVELOPMENT

A number of social scientists have reviewed the literature on professional development and synthesized a body of knowledge that helps decide what to include in professional development practices (Black & Atkin, 1996; Fullan, 1991; Lieberman & Miller, 1990; van den Akker; 1998). The aim was either to find ingredients for change or that which constitutes professional development with long lasting effects. Loucks-Horsley et al. (1998) have since synthesized a list that deals with the rationale and practices of effective professional development programmes. This seven-item list is referred to as principles of effective professional development. These authors posit that effective professional development practices:

i. are driven by well-defined images of effective classroom learning and teaching;
ii. provide opportunities for teachers to build their knowledge and skills;
iii. use, or model with teachers, the strategies teachers will use with their students;
iv. build a learning community, (…) teachers learn and share together;
v. help teachers serve in leadership roles, (…) as supporters of other teachers, as agents of change, and as promoters of reform;
vi. provide links to other parts of the education system, i.e. those which are systemic;
vii. continuously assess themselves and make improvements to ensure positive impact on teacher effectiveness, student learning, leadership, and the school community.

These principles provide key ingredients for designing potentially successful professional development programmes as well as criteria for evaluating professional development approaches. One such approach, the SEITT approach, is defined in the next section after which it is appraised.

3.3 INTRODUCING THE SEITT APPROACH FOR PROFESSIONAL DEVELOPMENT

Details of the SEITT approach have already been given in section 2.4.2 of this dissertation. However, a brief summary will now be presented. In short, the SEITT approach (Ncube & Engels, 1995) is a professional development plan put together to address some problematic areas within the teaching of A-level science and mathematics. The first set of problems had to do with the quality of teachers with regard to their level of either subject content or teaching methodologies. One set of teachers was identified to have good subject content knowledge but little training, and sometimes none at all in pedagogy. The other teachers were graduates of teacher training colleges who did not have sufficient grounding in their respective subject content areas. The SEITT approach had to elevate teachers from their respective positions to specialist positions in pedagogical content knowledge. The second set of problems related to the lack of sufficient and up-to-date teaching materials. Efforts to solve these problems led to the development and implementation of the SEITT approach for professional development whose aims, objectives, and design are discussed in the following subsection.

3.3.1 AIMS, OBJECTIVES, AND DESIGN OF THE SEITT APPROACH

The SEITT approach was aimed at improving the quality of science and mathematics teaching at A-level, and to establish, at the provincial level, a self sustaining and prolonged in-service programme run by a pool of well-trained resource teachers. To achieve these aims, the SEITT approach had the following objectives:

- produce a well trained set of resource teachers;
- establish science and mathematics centres at the provincial level;
- utilize a body of resource teachers to organise and run PCK workshops, and working with teachers, engage in curriculum materials writing, and co-ordinate various aspects of teacher networks.

Before the components of the SEITT approach are considered, an outline and discussion of the design process of the SEITT approach is presented.

Table 3.1
Stages in the planning of the SEITT approach

Stage	Activity	What should be implemented?	Observations
1 1994	SEITT personnel study the original SEITT project document. DSME SEITT structures set up.	▪ DSME lecturers to be trained in INSET strategies. ▪ DSME lecturers to organise and run national workshops to provide INSET targeted at all A-level teachers in Zimbabwe. ▪ Investigate possibility of decentralising training teachers to organise and run own inset activities in their provinces.	1. This is a top down model. 2. Its designers are uncertain about its operability and have suggested that DSME consider decentralising the project. 3. Option to decentralise is taken.
2 1994	Decentralisation study is undertaken. Consultations with MoESC and teachers done. New project document detailing SEITT approach is produced.	▪ Cascade model of training starting with DSME core staff. ▪ RTs to be trained through short intensive course at UZ and given a certificate of attendance. ▪ SEITT approach with its five components implemented at provincial level. ▪ Model subject to acceptance/ modifications by implementers. ▪ Pilot SEITT in five provinces.	4. Teacher led professional development adopted. 5. In-service now happens at provincial level nearer the teachers' workplace. 6. Model is flexible, stakeholder inputs to be sought and incorporated. 7. Model to go through piloting with formative evaluation and adjustment phase.
3 1995	Initialising workshops with Education officers and teachers to discuss draft project plan are carried out nationwide. Document detailing SEITT approach is produced.	▪ Training of RTs at post graduate diploma level. ▪ No piloting. Project to be implemented nationwide. ▪ Establish SMCs, one per region. ▪ EOs and RTs work as colleagues to manage the programme at provincial level.	8. Short training programme rejected by teachers insisting on a programme leading to formal post graduate qualification. 9. Piloting rejected by MoESC insisting on nationwide implementation.
4 1995	Meeting for UZ and MoESC senior management.	▪ Negotiation on matters of policy. ▪ Criteria for SMC locations. ▪ MoESC director's circular for provinces to identify schools and set up SMCs. ▪ Formulation of management committee (MC) concept for administration of provincial INSET programmes. ▪ Proposal for reduction of RT teaching loads.	10. Guidelines for operationalisation of SEITT produced. 11. MoESC to consider financial motivation of RTs and salary notch for all RT graduates.

Stage one presents a scenario where the initial project plan of SEITT is a top down approach to professional development that involves a university developed programme using university personnel to organise and run nationwide PCK workshops for teachers. The designers of this model, however, appear uncertain of the model and thus make a suggestion to later project team to start by investigating the possibility of decentralising the model. In stage two, the decentralisation study is carried out. The original model is abandoned in favour of a cascade, decentralised, teacher-run programme, where university personnel assume new roles as technical advisers. RTs become the central persons in running the professional development programme. PCK workshops that were originally supposed to be run by the university are now run by RTs, drawing resource persons from universities, colleges, and industries. The programme bases itself in the provinces and is managed on a day-to-day basis at that level.

During initialising workshops (stage three), the decentralised model was accepted, and the roles of EOs in the programme were negotiated and agreed upon. MoESC rejected piloting the project, insisting on nationwide implementation. This resulted in the project covering all nine provinces but without an increase in project budget. Rejection of RT training through a short intensive course, in preference to a post graduate formal university diploma, led to a slow start in project implementation. All EOs and more than 90% of the teachers were reached during these workshops. In stage four, the university engaged MoESC senior management to explain the programme, and discussed the way forward. This meeting resulted in MoESC identifying and setting up SMCs. Management committees (MC) were defined together with their structures and function. Tentative agreements on policy issues related to the time it would take for teachers to do professional development, remuneration for extra professional qualifications after RT education, and reduction of teaching loads for SMC resident RTs were made.

Considering this outline and discussion, it is concluded that project planning was:

- evolutionary;
- interactive;
- deliberative.

3.3.2 ASSUMPTIONS IN THE DEVELOPMENT OF THE SEITT APPROACH

The structure and elements of the SEITT approach were presented in section 2.4. From this presentation and that of 3.3.1 it can be deduced that a number of

assumptions guided the rationale behind the design of the SEITT approach. These assumptions are outlined below and will later assist in the formulation of criteria for the evaluation of the SEITT approach's implementation. The approach assumes that:

1. Change from a centralised, university-run teacher professional development programme to a provincial based programme is best run if based nearer the point of practice of teachers.
2. Once teachers are empowered through education and training, they are capable of running professional development programmes aimed at improving classroom practice.
3. Whilst using teachers (RTs) to professionally develop other teachers, it is still necessary that resource persons from outside the school system contribute in PCK workshops.
4. It is necessary to put in place structures for implementation, management of the innovation, and involvement of people from outside of education.
5. The cascading of training is effective in filtering professional development from university to classroom practitioners.
6. Teachers and education officers, occupying widely different rungs on the MoESC bureaucratic ladder, can work as colleagues in professional development.
7. A multiple perspective approach to professional development was likely to address the problem of teaching and learning with understanding. The following components were deemed essential ingredients in the overall strategy: resource teachers, resource centres (science and mathematics centres in SEITT approach), exemplary curriculum materials, networking, technical support, and research.

3.4 APPRAISAL OF THE SEITT APPROACH

Section 3.2 offered an outline of what professional development is and what constitutes effective professional development. It was followed by section (3.3) that defined the object, the SEITT approach itself. In this section, the elements of the SEITT approach are analysed and evaluated from a literature perspective. Principles of effective professional development are used as criteria for the evaluation.

3.4.1 RESOURCE TEACHERS

The concept of resource teachers has been around for some time. In the 70s and 80s, they existed in the UK (Weindling, Reid & Davis, 1983) and they are discussed more recently by a number of authors (Fairhurst, 1999; Gibbs & Kazilimani, 1999;

Knamillar, 1999; Knamillar, Maharjan & Shrestha, 1999; Welford & Khatete, 1999) with respect to their existence in places as varied as Zambia, India, and Nepal. These authors see resource teachers as teacher leaders well-versed in professional development methodologies and techniques. They identify the task of resource teachers as primarily to organise and run professional development activities for other teachers. Included in this would be planning for in-service training of teachers, encouraging curriculum development, responding to teachers' needs, and co-ordinating the professional development activities that teachers do with education ministries or other sponsors. In the UK, resource teachers organised in-service activities at the resource centres, and also visited schools to offer advice. Some of this literature identifies areas where the resource teacher job has been a permanent post, also requiring a considerable amount of freedom to enable the incumbent to make decisions (Fairhurst, 1999).

The role of resource teacher as defined above exhibits some problems stemming from the very structure of the ministries of education. The British resource teacher faced resistance from school heads who preferred advice from an official of similar rank as themselves (Weindling et al., 1983), whilst Local Education Authority inspectors felt that visiting schools and advising teachers was their business and not resource teachers', who were, after all, just teachers. Referring to the re-emergence of the resource teacher conception in developing countries, Hoppers (1998) concluded that bureaucratic structures in most developing countries would make it difficult for the resource teacher conception, as defined in the British sense, to function. Ball (1996) questioned the wisdom of advocating teachers to in-service other teachers, arguing that this was pushing teachers beyond their present horizons, but at the same time he acknowledged the difficulty of those outside teaching setting the agenda of professional development.

The above literature is inconclusive with respect to the efficacy of the resource teacher strategy. One reads incidences where the conception has been used but without evaluative information to suggest its effectiveness. Wilson and Berne (1999) state that very little is known about what teachers learn during teacher-led programmes. Fullan (1991) is not opposed to the concept but advises that change agents need to fully understand and be committed to the change as well as be skilled in the change process itself. Involvement of resource teachers as teacher leaders is supported by the principle of professional development number v. Whilst this is the case, and judged appropriate as a general professional development strategy, literature suggests caution with this strategy, especially in environments where the freedom of

teachers to make decisions might be limited. In the case of SEITT, the system is fairly bureaucratic, with the existence of science education officers who are traditionally in charge of the teaching of science subjects. Under normal circumstances, EOs act as inspectors of schools and evaluators of teachers with respect to the teaching of science or mathematics. Traditionally, therefore, the relationship between EOs and RTs is that of superior and subordinate, respectively. The success of this model partially depends on how EOs and RTs relate with each other in the field, as well as the way RTs implement their roles. Such leadership is facilitated through formal training (Griffin, 1995; Katzenmeyer & Moller, 2001; Sherril, 1999).

3.4.2 RESOURCE CENTRES

Referring to their existence in the UK and USA in the 70s and 80s, Khan (1982) lists the purposes and functions of resource centres as:

- dissemination centres for new curricula or information about changes in existing curricula;
- dissemination centres for materials used in project innovations;
- meeting places for teachers to share ideas, learn new teaching skills, and help each other solve immediate classroom problems;
- places that run courses meant to "eliminate teacher deficiencies".

As teacher-centred facilities, resource centres gave teachers the opportunity to discuss curricular issues and offer input in an environment away from the stifling hierarchies of their school heads and inspectors. Due to changes in financing arrangements, the need to decentralise from in-service to school level, and the general increase in resources in individual schools, the resource centre concept became redundant in the United Kingdom.

Perceiving an export of the resource centre concept to other countries, Khan advises would-be adopters to adapt the concept to their local conditions. Hoppers (1998) agrees with Khan's view and adds that the UK centres were influenced by British educational and cultural settings, hence any would-be adopters should adapt the conception to their own settings. Fairhurst and Knamillar (1999) argue that the settings described by Khan are those of the 1980's, and they make the following assumptions about teachers and their environments: teachers enjoy a high degree of autonomy, are experienced, reflective, and stable with respect to their jobs. This is not necessarily the case in other countries. Power in some countries is vested in the ministries of education and its departments and very little in the teacher. Hoppers

(1998) argues that the emergence of teacher centres in Southern Africa amid periods of political instability and poor economic growth are ways for teachers to try to create for themselves autonomy in otherwise bureaucratic structures. They can be interpreted as reactions to deal with educational problems.

Resource centres have resurfaced in developing countries (Fairhurst & Knamillar, 1999). These authors note that in Zambia and India, the programs were centrally determined and controlled, and at the same time were meant to bring about reflection on practice, exchange of experiences, and development of curriculum materials. In India particularly, the meetings were so tightly structured that meaningful discussions of problems and exchange of ideas was minimal. In both situations the centre programmes had minimal impact.

A conclusion might be that genuine reflection and sharing of experiences by teachers can only happen in a free atmosphere and out of free will, and not by authoritative mandate. A centrally determined programme of activities cannot therefore achieve such objectives. The issues are not so much against the concept as they are against the stifling approach of education management. British centres were characterised by their considerable freedom—freedom which was lacking in the two developing world cases. An analysis of the SEITT case in view of the freedom that existed in UK and US centres, as well as the problems cited in the two developing world cases, shows the following:

1. As opposed to the majority of studies cited by Fairhurst and Knamillar (1999), which were at primary schools, Zimbabwean teachers involved in SEITT teach at A-level. Science at this level is subject-specific, and teachers have a fair degree of autonomy in selecting teaching resources (text and laboratory materials).
2. When resources are limited, the need to share the little that is available becomes greater. Part of the functions of British resource centres was the receiving and redistribution of curriculum materials for various programmes. SEITT, as discussed in section 2.4.2, intends to produce such materials, hence a distribution centre is essential.
3. By including education officers in the implementation process SEITT can eliminate direct competition between RTs and EOs, simply by bringing the two to work together.
4. A resource centre scenario requires that teachers have time to access materials and be assisted in accessing the same through provision of transport by their schools. In the Zimbabwean scenario, this might prove problematic. Schools

work with tight teacher-pupil ratios, thus teachers have to teach all their classes first before they can visit resource centres. Schools also have funding problems, hence teachers might have to use their own funds to visit resource centres for access of teaching materials. A typical Zimbabwean teacher might not be willing to use their time and resources in this manner.

Given the above analysis, the choice to include resource centres in the SEITT approach would appear justified, although their functionality as sources for materials to facilitate everyday teaching is questionable.

3.4.3 EXEMPLARY CURRICULUM MATERIALS

Including curriculum materials in innovations has the advantage that these materials can be tailor-made to fit the context in which they are to be used. The intention may be to improve subject content among teachers or to improve their pedagogical content knowledge. In either case, use of curriculum materials is considered useful as they promote teacher learning. A considerable number of studies involving the development and use of curriculum materials have been reported over the years (Dlamini, Coenders & Stronkhorst, 1995; Lubben, Campbell, Dlamini & Putsoa, 1995; Ottevanger, 2001; Stronkhorst, 2001; Thijs, 1999; van den Akker, 1988; van den Berg, 1996, 2001). Van den Akker, for example, found that curriculum materials assisted teachers in the planning stages of a lesson by offering "procedural specifications", i.e. "accurate how to do it advice focussed on essential, but apparently vulnerable elements of the curriculum" (p. 50). Well-structured curriculum materials continue to teach teachers as they use them. New materials therefore put teachers in a learning situation. They require teachers to change their teaching behaviour, and potentially cause corresponding changes in their beliefs, attitudes, and understandings. Due to their researched usefulness, curriculum materials have been used to support innovations in various countries (Netherlands [SPIN project], Namibia [INSTANT project], Botswana [UB-INSET project], and Swaziland [SMART project]). All these projects included curriculum materials as a vehicle for bringing about learner-centred teaching and learning. Use of curriculum materials in these studies produced the following conclusions:

- Inclusion of accurate how-to-do-it advice is especially helpful in the early stage of the implementation process. In the long run, more in-depth and ongoing in-service education and support seems to be more successful (van den Berg, 1996, 2001, Netherlands).

- Teachers achieved reasonable success in implementing learner-centred teaching that was supported by curriculum materials. Teacher and student reactions to these materials were positive (Ottevanger, 2001, Namibia).

Besides the success of procedural specifications in curriculum materials, a study by Dlamini et al. (1995) in Swaziland showed differences in the use of curriculum materials, with experienced teachers not using the materials as expected whilst inexperienced teachers followed them to the letter. When the materials were used, students reported shifts in teaching practice, with less notes being given and more practical activities being done. The authors concluded that from a quality perspective, the programme was effective since it brought about changes in the classroom that could be observed as well as confirmed through student observations of their teacher's practices. They, however, note that the number of teachers who used the materials was far less than expected. Moreover, experienced teachers did not use the materials as intended.

When required to write their own curriculum materials (Lubben et al. 1995), teachers initially resisted, arguing that writing curriculum materials was not their business. Teachers later embraced the idea after realising that the materials were helpful in getting students to understand science concepts more easily. In the COAST study in Botswana by Thijs (1999), where use of materials was again investigated, teachers used the materials but ran into the general problem of time for both planning and effecting lessons.

These studies indicate the potential for the use of curriculum materials generated within the countries in Southern Africa. In situations where teachers are required to learn new content and teaching methodologies, curriculum materials have been shown to assist. Furthermore, use of curriculum materials allows the teacher to play a facilitative role in learner-centred teaching. What teachers learn in workshops is continued through curriculum materials, which therefore act as tools for providing follow-up of professional development activities.

Curriculum materials therefore appear useful in the following situations:

- Where teachers are expected to transfer what they learn in workshops into classroom practice. Curriculum materials are a transfer mechanism (Loucks-Horsley et al., 1998).

- Where teachers need assistance with contextualising content. Tailor-made curriculum materials have been found to support this (Dlamini et al., 1995).
- Where teachers are expected to teach in a more learner-centred way. Materials that guide students through activities empower students whilst freeing teachers to concentrate on supervision. Such materials have been proven to work (Ottevanger, 2001).

In the light of these research findings, including curriculum materials in the SEITT plan was a good idea. This conclusion is also supported by the principle of effective professional development number two. In all the above successful cases, however, curriculum materials were written by experts and then placed in the classroom. SEITT on the other hand plans to get teachers to write these materials on their own. The finding by Lubben et al. (1995), however, suggests that caution needs to be taken in getting teachers to write their own materials. Whilst the use of curriculum materials in the innovation is supported by the literature, and is therefore a good idea for SEITT, teacher writing of such materials might not yield the desired results.

3.4.4 TEACHER NETWORKS

Loucks-Horsley et al. (1998) define a network as an organised professional community that shares a common theme or purpose. Lieberman (1996) refers to networks as learning communities. Moonen (2001) defined a teacher network as a "group of teachers from different schools that co-operate for a longer period of time on the implementation of a certain innovation in education" (p.18). Together these definitions imply that any grouping of people who periodically share information through meetings or any other form of communication, electronic or otherwise, is some kind of network. Collaborations could constitute very small and localised networks whilst electronic networks could be small or large and could involve large distance communication. Fullan (1993) states that networks are a tool for change.

Networks can facilitate collaboration among teachers and between teachers and subject specialists. The mode of networking can be face-to-face, or where distance is a factor, Internet communication mode becomes the network of choice (Bos, Krajcik, & Patrick, 1995; Dadds, 1997; Huberman, 1989, 1995). Networks also offer teachers and administrators an opportunity to discuss their work and tackle problems in an atmosphere of trust and support (Lieberman, 1996). Stakeholder meetings, focus groups, face-to-face dialogue, information sharing groups, and

ongoing written and oral updates (Moffet, 2000) are all forms of networks that could be set up to discuss issues in an ongoing innovation. Networks have the following advantages (Lieberman & McLaughlin, 1992): they are focussed in that they target a specific area of teaching such as subject content or teaching method; they offer variety in workshops, conferences, internships, and other in-service activities; through exchange of ideas on tough and enduring teaching problems, they are discourse communities. In these communities, members generate knowledge in the same way that they expect their students to.

Teacher networks also open up opportunities for teachers to be recognised by their peers, principals, and administrators across schools and provinces as well as offer opportunities for them to access information from places that would otherwise be closed to them (Pennell & Firestone, 1998, Veugelers & Zijlstra, 1996). Networks also open doors so that teachers can get out of their isolation (Vulliamy & Webb, 1991).

Lieberman and McLaughlin (1992) identify a number of problems caused by networks. These range from shifting teacher focus too much from their own schools to the network itself, to requiring teachers to play new roles they might not be familiar with, thus causing anxiety. Furthermore, agendas in networks are not always transparent. The lack of flexibility in some networks can also be a problem. The ability of networks to bring about critical reflection depends on how much individuals are prepared to open up. Teachers in the INSTANT project (Ottevanger, 2001) could not meaningfully critique each other after a micro-teaching lesson. Critical feedback was seen as a culturally inappropriate attack on a colleague, suggesting that direct and critical feedback from peers in teacher networks might not be entirely forthcoming. Running effective networks requires highly trained leadership that is able to keep the group focussed and flexible at the same time.

SEITT set itself an objective to remove teachers from their isolation. They aimed to have teachers share ideas in workshops, subject groups, and through direct networking using Internet. The literature cited above confirms that such objectives could be achieved through networking. The principle of effective development number (iv) agrees with this strategy since it has the effect of developing learning communities of teachers and supports teacher discussions of their teaching experiences. Having said this, however, networks in the SEITT approach were likely to face a number of obstacles. For instance, face-to-face networks would encounter obstacles in the form of time constraints, financial resources to facilitate meetings,

and the general cultural tendency to be isolated. Electronic networks would also encounter infra-structural problems, financial problems with respect to huge telephone bills in an impoverished environment, and lack of skills by network members to run IT related networks. Lack of skilled leadership would hinder their function. Such problems would make networking very difficult. In the SEITT situation, limiting networking to face-to-face discussions among teachers in a formal scenario would appear more practical than the varieties of networks the strategy advocates.

3.4.5 TECHNICAL SUPPORT

The following two paragraphs consider technology based and non-technology based technical support.

Technical support, according to Ertmer (1999), generally offers teachers or other users help that ranges from general use of computers and peripherals to software specifics and running of computer programmes. General trouble shooting and simple maintenance is also included. Solomon and Solomon (1995) state that fears of technology failures convince teachers not to try using IT. By their very nature, technical problems are easy to solve but can cause real problems for teachers (Means & Olson, 1994). Technical support must be on-site and is a critical ingredient to successful technology use (Hadley & Sheingold, 1993). Networking with other schools, universities, industries, and teacher education colleges might provide such urgent technical support (Ertmer & Hruskocy, 1999).

On the non-technology side, technical support is also considered necessary. For instance, Miles, Saxl and Lieberman (1988, 1989) argue that projects are more sustainable if designated change facilitators provide general support and technical assistance. Fullan (1991) has stated that an implementation dip occurs when teachers transfer knowledge and skills that they have learnt through training. When in an implementation dip, things get worse, anxiety increases, and class discipline might appear to become difficult. It is at this point that teachers require the most amount of social as well as technical support. According to Joyce and Showers (1988), this support can make the difference between failure and success. The life of an innovation is dependent on the amount and quality of such assistance (Huberman & Miles, 1984; Louis & Miles, 1990).

Literature in both technology based and non-technology based implementation scenarios seems to be conclusive concerning the need for technical support. The SEITT approach has both technology-based aspects (IT use) and non technology based aspects. Readiness by the project to provide technical support in both implementation scenarios, therefore, seems to be relevant. Such technical support would become even more relevant as implementation reaches classroom level, where according to Fullan (2001), the implementation dip is likely to manifest itself. As such, inclusion of technical support in the SEITT approach was a wise choice.

3.4.6 RESEARCH

In the Zimbabwean scenario, most of the work that RTs are being called upon to do has not been done before. This means there is generally no research information to inform most of their practice. As such it is desirable that they engage in continual, disciplined inquiry conducted to inform and improve their practice as educators (Calhoun, 2002). Such research serves to generate information that enables teachers to understand their practice, guide practice, make comparisons between what they do and what others have done, and participate in professional development to support needed change. As an example, RTs and teachers can be empowered through research to write materials that are relevant to their environments. They can also do research on those materials to obtain information relevant to their improvement. Even more than that, Calhoun (2002) states that research has the potential to change the social system of an organisation so that continual learning is both expected and supported, superficial coverage is replaced with depth of knowledge, and such research will generate data to measure the effects of various programmes and methods on student and staff learning.

Individual teachers may do research work in isolation or in collaboration with other teachers or university lecturers (Hollingsworth, Dadds & Millar, 1997). Knight and Wiseman (2000) assert that collaborative research is essential to the professional development of teachers. Such collaboration has the advantage that university faculties in this collaboration provide teachers with the necessary research skills (Blasé & Blasé, 1994). Blasé and Blasé also argue that the cooperation of teachers and university faculty to gather and share information about results on teacher performance motivates teachers to improve on their practice. The findings for such research constitute local knowledge that is useful for solving local problems (Knight & Wiseman, 2000). Lytle and Cochran-Smith (1994) also add that such research knowledge provides collective local knowledge, which can in turn guide decision

making for both teachers and university faculty. Knight et al. (2000) state that interventions designed by teachers are more closely matched to the needs of their students compared to interventions originating from university faculty working in isolation. For the individual, collaboration contributes to the professional image, self-confidence, and positive attitudes of teachers towards the partnership (McCorkel-Clinard & Ariav, 1998).

It is noted, however, that teachers in general lack the time and the training to do research, and besides, because they have a personal stake in classroom issues, their objectivity would often be lacking (Anderson & Herr, 1999).

In the SEITT approach scenario, numerous areas are ripe for research such as the concepts of RTs, SMCs, teachers as leaders of professional development, power issues in a scenario that tries to curb freedom for teachers in a traditionally bureaucratic system, RT-teacher interactions at PCK workshops, etc. Inclusion of research in professional development is supported by the principle of professional development number vii. The question, however, is who should do this research? Whilst Anderson and Herr (1999) argue that teachers do not have the time and expertise to do research, indeed, in the SEITT situation they do not have both. The real situation on the ground is that RTs are still trying to master their leadership roles and to implement a considerably difficult task. Adopting an even more difficult function, that of researcher, would make their job extremely difficult. Even if they were to do research, the question would still remain: can RTs and teachers monitor themselves through research? That would seem unrealistic in the situation teachers and RTs are in. At the same time, leaving teachers out of the research scenario would be difficult since they also need the empowerment that comes with this exercise. Therefore, inclusion of research in SEITT can not be justified as a specific role of RTs or teachers, but it may be relevant and feasible if it involves RTs and teachers in a collaborative arrangement with university lecturers.

3.5 CONCLUSION

In this chapter, science education in-service teacher training (SEITT) has been reconstructed and appraised in the light of literature on effective professional development. The appraisal leads to the conclusion that the SEITT approach is likely to be effective (since it incorporates aspects that address the identified problem in the education scenario) and valid (since it includes aspects that are

supported by the literature and embodies most of the principles of effective professional development). Curiously, however, the principle of professional development number vi has not been addressed. This is a crucial principle since it associates effectiveness of professional development designs with a systemic approach to change (Loucks-Horsley et al., 1998). As such, failure to address the examination side is likely to present teachers with a dilemma since teaching and learning for understanding is considered achievable through use of constructivist approaches, and yet examinations, in their current state favour more traditional approaches. Faced with this dilemma, teachers will likely choose to align themselves with examinations, and hence resist the constructivist approach. Secondly, it is unrealistic to expect RTs to successfully implement all the components of the SEITT approach, especially considering the results of studies that have employed these approaches in the past (Dlamini, et al. 1995; Knamiller, 1999; Moonen, 2001).

- 4 -

BASELINE STUDY: INVESTIGATING PERCEPTIONS OF THE SEITT APPROACH

This baseline study investigates RT perceptions of the adequacy of preparation for their roles by the diploma programme and the perceptions they held about their roles as RTs after they had completed this two year education and training programme. Since RTs worked closely with school heads and education officers, both group's perceptions of RT roles and SMC functions were likely to influence the way RTs translated their perceived roles and functions into practice and influence the way SMCs function. The study therefore included these two groups. Section 4.1 presents the research questions. The methodology for the study is presented in section 4.2 with section 4.3 presenting the results. Section 4.4 carries out an analysis that compares RT and stakeholder perceptions with the Science Education In-service Teacher Training (SEITT) approach regarding RT roles and SMC functions. Section 4.5 draws conclusions. The implications of findings to RT training and field practice are discussed in section 4.6.

4.1 RESEARCH QUESTIONS

This baseline study was done to answer the following questions:

1. *How well did RTs feel the diploma programme prepared them for specific roles within the SEITT approach?*

2. *What were RT perceptions of their roles compared with those of the SEITT approach?*

3. *What were stakeholder perceptions of RT roles and SMC functions compared with those of the SEITT approach?*

Question 1 was meant to establish RT perceptions of how well the diploma programme had prepared them for some specific functions within the SEITT approach. This information was later going to pave the way for an analysis related to the match between what RTs perceived and what was intended by SEITT through the diploma programme.

Since RTs were now the in-service specialists within their provinces, what was implemented would very much depend on what they thought was within their roles and capabilities. The second question, therefore, sought to first identify these roles as well as compare them to those defined by the SEITT approach. This enabled predictions about what was likely to happen in the field.

Whilst RTs may have wanted to be as faithful to their own conceptions of their roles as identified in question 2, they worked among and with people (school heads and EOs) who wielded more power than themselves with respect to the MoESC hierarchy. School heads and EOs were also members of the management committee (MC, a decision making body for provincial professional development activities) thus giving them direct influence on what and how teachers were going to be developed. It was, therefore, inevitable that school head and EO perceptions of RT roles were likely to influence RT activities. Consequently, perceptions of both school heads and education officers in regard to RT roles and SMC functions were investigated. Question 3 was used to guide this part of the research.

The answers to the above questions facilitated a comparison between what the SEITT approach intended and what RTs thought they had actually learnt and therefore were able to implement. What the SEITT approach intended as the roles of RTs and the functions of SMCs, and what was perceived as their roles and functions was also at stake. The last part of question 3 facilitated this comparison.

4.2 METHODOLOGY OF THE BASELINE STUDY

4.2.1 SAMPLING

A total of 48 RTs had completed their training by 1998. Due to this number and the research methodology (see section 4.2.2) employed in the study it was found prudent to include all of them in the study. These RTs were spread throughout the nine education provinces of Zimbabwe. At the time of this research, ten school

heads who headed schools where SMCs had been established had adequate knowledge of both RTs and SMCs. Three of these ten heads were particularly accessible in terms of travel time for the researcher. Therefore, these three were included in the sample. Included in the sample were three EOs in the same provinces as the sampled school heads. These were directly involved with the programme and were accessible.

4.2.2 DATA GATHERING PROCEDURES, INSTRUMENTS AND DATA PROCESSING

BASELINE STUDY

Questionnaires for the baseline study were sent to all the 48 RTs using the addresses they had provided during the diploma programme. A return addressed and stamped envelope was included with each questionnaire. The questionnaire return rate for this study was 75% (36 questionnaires). A follow up, mostly by telephone to increase the return rate, established that some of the RTs had since moved from their last known address whilst others kept promising to complete and send the questionnaires but never did.

The questionnaire was divided into four sections, with each section collecting information that was related to a particular area of interest. Those questions requiring a *yes*, *partly,* and *no* answer were accompanied most of the time by a further question that required RTs to express an opinion related to their response. A copy of the questionnaire is included in Appendix B1.

Questions that involved frequency counting were coded and processed using SPSS. All reasons and explanations were summarised and recorded as per the question in which they occurred.

Data from school heads and EOs were obtained through structured interviews. The interview questions were generally structured in categories similar to those in the RT questionnaire. A copy of the interview schedule is included in Appendix B2.

All of the identified potential interviewees agreed to be interviewed, were available in their offices for interviews, and consented to tape recorded interviews. All recorded interviews were later transcribed and the transcriptions subsequently summarised. The summaries were first done for each interviewee and then collapsed into the two groupings of interviewees, i.e., school heads and EOs. Interpretation involved extraction of the meanings and explanations given by the individual groups

of interviewees as well as searching for commonalties across groupings. In all cases, the original transcriptions were kept and referred to whenever a more detailed description or illustration was required.

4.3 RESULTS OF THE BASELINE STUDY

4.3.1 RT PERCEPTIONS ON THE ADEQUACY OF ROLE PREPARATION AND THEIR IDENTIFIED ROLES

The first part of this section presents results on RT perceptions concerning how the diploma training programme prepared them for their roles. The results specifically answer the first research question. RT responses are summarised in Table 4.1. The roles labelled 1-5 are SEITT assigned roles. Any other role RTs identify with will be assigned 'other' and listed after the five roles assigned by SEITT.

Table 4.1
Perceived preparation of RT roles by diploma programme

RT roles *(n = 36)*	**Yes** *%*	**Partly** *%*	**No** *%*
1. PCK workshops	86	11	3
2. SMCs managers	75	17	6
3. Write curriculum materials	31	63	6
4. Co-ordinate teacher networks (including IT)	78	19	3
5. Research	86	8	3
Other (non SEITT assigned roles)			
6. Source human and material resources for your INSET programme	64	33	3

RTs felt adequately prepared (above 75%) concerning 4 out of 5 SEITT specified roles. PCK workshops and research registered the highest (86%) rate of success. RTs indicated inadequate preparation for writing curriculum materials (31%).

The list of roles that RTs identified were weighted and ranked. The results are shown in Table 4.2. This part responds to the first part of the second question of this research.

Table 4.2
Weighted ranking of perceived RT roles (n =36)

Role	Rank
PCK workshops	1
Research	2
Co-ordinate teacher networks (including IT)	3
Write Curriculum materials	4
SMC manager	5

Table 4.2 shows first the roles that RTs identified for themselves. The table also shows that RTs perceived PCK workshops (organising and implementing) as the most important role whilst seeing the SMC manager role as the least important. Also worth noting was the result in the questionnaire that asked them to add any extra roles they perceived doing during their practice. Although there were no significant additions to the list of roles, one "protest role" was mentioned by three respondents. The addition was 'volunteer workers' in apparent protest for not having been awarded an extra notch to their salaries after graduating in the diploma programme.

4.3.2 STAKEHOLDER PERCEPTIONS OF RT ROLES AND SMC FUNCTIONS

The results from interviews with school heads and education officers concerning the roles of RTs and functions of SMCs will be presented in this section. The results address the first part of the third research question which asks: *What were stakeholder perceptions of the roles of RTs and function of SMCs, respectively, compared with those of SEITT?* Perceptions of both school heads and education officers are presented in Table 4.3.

Table 4.3
RT roles as identified by school heads and education officers

	Identified by	
RT roles	**School Heads** *(n = 3)*	**Education Officers** *(n = 3)*
1. PCK workshops	3	3
2. SMC managers	2	2 + SMC librarian
3. Write curriculum materials	0	0
4. Co-ordinate teacher Networks (including IT)	0	1
5. Research	1	1
Other (non SEITT identified role)		
6. Co-ordinate between teachers and the school head for school head to act	1	

There was some commonality in what the school heads perceived as the roles of RTs among themselves. All three school heads mentioned the PCK workshop role, but none of them mentioned the curriculum materials writer role or the network co-ordinator (IT) role. Only one school head mentioned the researcher role. One school head expected RTs to feed her with information in order for her to facilitate rather than for the RTs to facilitate. All three EOs cited the roles of RTs as PCK workshop organisers and implementers and SMC managers. One EO specifically cited the role as SMC librarian rather than SMC manager. None of the EOs mentioned the role of the RT as a writer of curriculum materials. Roles four and five were mentioned by one EO each. Role six was in addition to the SEITT roles and was only mentioned by one school head. This role shows a possible misconception of the function of RTs in relation to the role of the school head of the SMC host school.

Between the two stakeholder groups, knowledge of RT roles on the whole appeared to be similar.

STAKEHOLDER PERCEPTIONS OF SMC FUNCTIONS

When asked what they thought were the functions of SMCs, school heads and education officers provided responses as shown in Table 4.4.

Table 4.4
SMC functions as identified by school heads and education officers

	Identified by	
SMC functions	**School Heads** *(n = 3)*	**Education Officers** *(n = 3)*
1. Meeting place for teachers	3	3
2. Workshop venue	3	3
3. Source for reference text-books and videos	3 library	2 library
4. Communication centre	3	0
5. Distribution centre for teacher authored materials	0	0
Other (non SEITT specified functions)		
6. Publicity centre for the programme	1	
7. Reprographics centre		2
8. Office that attends to teacher problems		1
9. Resource centre where teachers can borrow equipment for examination purposes		1

When probed for reasons why they had given certain functions of SMCs, school heads suggested that it was because that is what was currently going on at SMCs,

and they had been involved in helping set up these structures. School heads, therefore, presented SMC functions according to what they had experienced as these structures were set up and used.

The EOs mentioned a range of functions as indicated in Table 4.4. Consistent with the perceptions of school heads is the functions of workshop venue, library, and meeting place for teachers. When the EOs who saw SMCs as "reprographics centers" were asked why SMCs had to be that, they argued that the presence of a photocopier made them that, and besides, schools desperately needed that facility to duplicate examination materials and student handouts. The EO who saw SMCs as an "office that attends to teacher needs" paralleled the SMCs to their EO offices where they attend to science teaching problems of teachers. To him, SMCs were to be that kind of place, thus overlapping RT duties with those of EOs.

Both groups of stakeholders' responses were similar with respect to the functions "meetings for teachers, workshop venue, and source for reference textbooks and videos". Section 4.5 compares the field understanding of SEITT with those of the SEITT approach.

4.4 COMPARING THE ROLES AND FUNCTIONS OF SMCS WITH SEITT DEFINED ROLES

The first subsection of this section will compare the roles ascribed to RT—by RTs, themselves, school heads, and EOs—with roles assigned to RTs by the SEITT approach. The second subsection will compare the functions of SMC as identified by the three groups with functions ascribed to SMCs by the SEITT approach.

4.4.1 RT AND STAKEHOLDER PERCEPTIONS OF RT ROLES VERSUS SEITT DEFINED ROLES

SEITT as a programme had defined the roles of RTs in advance of the implementation of the approach. Until now these roles (see the left column of Tables 4.1, 4.2, and 4.3) have been used to focus RT, school heads, and education officer identified roles. This section compares perceived roles with those defined by the SEITT programme and in so doing addresses the second parts of Questions 2 and 3.

To what extent did RT and stakeholder perceptions differ from the SEITT programme defined roles of RTs?

Table 4.5
Comparing SEITT defined RT roles with those perceived by RTs, school heads, and education officers

		Identified by	
SEITT assigned RT roles	*RTs*	*School Heads*	*Education Officers*
1. PCK workshops	✓	✓	✓
2. SMC managers	✓	✓	✓
3. Write curriculum materials	✓	*x*	*x*
4. Co-ordinate teacher Networks (including IT)	✓	*x*	✓(1)
5. Research	✓	✓(1)	✓(1)

The RT roles as identified by the SEITT programme are listed in Table 4.5. The numbering serves only identification purposes and should not be read to suggest any order of importance. RT, school head, and EO perceptions that coincide with the SEITT defined roles are represented with a tick (✓) whilst those that are not are indicated with a cross (*x*). Table 4.5 summarises the perceptions of all three groups of respondents with respect to RT roles, with the SEITT defined roles located in the first column. Compared to these roles, these results indicate generally that the majority of RT roles as defined by the SEITT approach are known by all three groups. More specifically, however, the well known roles are RT as PCK workshop provider and SMC manager. Among these roles (as seen in Table 4.3) one EO refers to the latter role as SMC librarian rather than SMC manager. Conspicuously unmentioned by all three groups is "write curriculum materials". In addition, the three school heads do not mention the role (Co-ordinate teacher Networks (including IT)) and only one out of the three school heads mentions the fifth role (research). In addition the EOs as a group seem to know less of the remaining roles, with only one of the EOs mentioning roles 4 and 5.

4.4.2 STAKEHOLDER PERCEPTIONS OF SMC FUNCTIONS COMPARED TO SEITT DEFINED FUNCTIONS

Table 4.6
Comparing SEITT defined SMC functions with those perceived by school heads and education officers

	Knowledge of SMC functions by	
SMC functions as defined by the SEITT approach	*School Heads*	*Education Officers*
1. Meeting place for teachers	✓	✓
2. Workshop venue	✓	✓
3. Source for reference text-books, books, and videos	✓	✓library
4. Communication centre (with IT)	✓	-
5. Material distribution centre	✓	-
6. Venue for subject group meetings when writing subject specific curriculum materials.	-	-

From these results, school heads were aware of five out of six SMC functions, with EOs seemingly aware of the first three functions. EOs, however, gave the third function as a SEITT library, rather than as a source of reference text-books and videos. Both stakeholder groups did not mention function six. In addition to the SEITT defined functions as shown in Table 4.6, school heads and EOs mentioned other functions as shown in Table 4.7.

Table 4.7
Extra functions of SMC as perceived by school heads and EOs

SMC functions as defined by the SEITT approach	**Knowledge of SMC functions by**	
	School Heads	*Education Officers*
7. Publicity centre	✓	
8. Reprographics centre		✓
9. Office that attends to teacher problems		✓
10. Resource centre where teachers can borrow equipment for examination purposes.		✓

School heads defended function six as something they saw happening as the centres were being introduced to teachers. The three functions of SMCs (7, 8, 9) on Table 4.7 assigned by EOs were inconsistent with SEITT assigned functions. Function eight (reprographic centre) would have been consistent had the EOs not suggested the SMC would act as a reprographics centre for schools to duplicate examination materials. This would be a deviation from the intentions of the SEITT programme for SMC (see section 2.4.1). Function nine (office that attends to teachers' problems) implied a transfer of EO functions to RTs.

When the perceived functions of SMCs by school heads and EOs are put together and compared with those ascribed by the SEITT approach, the resource centre and reprographics functions as identified by EOs were at variance with the SEITT approach's defined roles and were likely to cause implementation problems due to the authority EOs wield within the provincial administration structure. Function nine is traditionally an EO function and therefore would suggest they viewed RTs as possessing sufficient authority to execute this role, suggesting they fully recognised RTs and SMC structures as capable of serving such roles and functions. Function ten would imply SMC materials could be borrowed and thus removed from the SMC by teachers and schools (see section 2.4.1).

4.5 CONCLUSIONS OF THE BASELINE STUDY

The results of the baseline study will be concluded here. The conclusions are grouped according to *RT perceptions* and *stakeholder perceptions*. In addition to this, further conclusions are drawn in relation to the comparison work done between the SEITT assigned roles of RTs and the stakeholder assigned roles and functions of RTs and SMCs, respectively.

RT PREPARATION FOR THEIR ROLES

With respect to the preparations for RT roles by the diploma programme, it is hereby concluded that the majority of RTs felt the diploma programme was:

Successful in preparing them to carry out activities such as PCK workshops, managing SMCs, co-ordinating teacher networks (including IT), and research, whilst inadequate in preparing them to write curriculum materials.

RT PERCEPTIONS ABOUT THEIR ROLES

RTs identified with all the roles assigned to them by the SEITT approach. When ranked, however, RTs viewed their roles with differing degrees of urgency. The roles of PCK workshop implementer and researcher were viewed as the most important in whilst the SMC manager role was viewed as least important.

SCHOOL HEAD AND EO PERCEPTIONS OF RT ROLES

The interviewed school heads and EOs perceived fewer roles compared to the ones identified by RTs and SEITT, with only one school head mentioning a role outside the ones expected. Both school heads and education officers did not identify the "writer of curriculum materials" role.

SCHOOL HEAD AND EO PERCEPTIONS OF SMC FUNCTIONS

A comparison between perceptions (held by school heads and EOs) of the functions of SMCs and those defined by the SEITT approach shows that school heads were aware of all five (1-5) functions whilst education officers perceived fewer functions of SMCs than those assigned by the SEITT approach, specifically functions five and six. School heads perceived the majority of functions of SMCs according to what they had witnessed actually at these centres (except function five) whilst the basis for EO perceptions was not clear. These two groups, however, perceived other functions that were outside the prescribed ones. Education officers

in particular perceived two roles that were contrary to what the SEITT approach intended, i.e. reprographics centre and resource centre (for lending materials to schools). Section 4.6 discusses the implications for the field practice of RTs if RTs and stakeholders continued to hold such perceptions.

4.6 IMPLICATIONS

The roles that RTs assigned to themselves and perceived prepared or not prepared for had implications and consequences for the implementation of the SEITT approach. The extra functions, especially those of reprographics centre and resource library assigned to SMC by education officers, also had some consequences for the implementation of the SEITT approach. The implications of these outcomes are discussed in this section.

It is possible from the roles that RTs identified with that these areas were likely to receive more attention in the field than those they felt inadequately prepared for. If this were to be the case, RTs would generally be expected to implement more in the following areas and order:

- PCK workshops;
- Research;
- Co-ordination of teacher networks (including IT);
- Managing SMCs.

The writing of curriculum materials, in the absence of any additional intervention, was likely to be problematic. In such a scenario, the implementation of all aspects of the SEITT approach therefore appeared unlikely.

The resource and reprographic—in the way stakeholders understood it—centre functions, were outside the SMC definition. The mismatch had the potential to cause operational difficulties for RTs, with SMCs expected to make their resources available for general utilisation by resource starved schools, especially through the borrowing of text-books by teachers and the use of photocopiers by schools for activities outside the SEITT approach intentions. Being held by an EO, such a mismatch was potentially problematic as it would set RTs against the wishes of their EOs.

The finding that combined EO and school head perceived roles, that covered the SEITT approach roles for RTs and similar functions for SMCs, was likely to work towards more complete implementation since both stakeholders were members of the management committee, with EOs participating in the annual national management committee, a body that planned annual activities for the SMC (see 2.4.3/2.4.4). The failure of school heads and EOs to identify curriculum materials writing as a role of RTs would not help generate attention to materials writing in the field.

- 5 -

EVALUATING THE IMPLEMENTATION OF THE SEITT APPROACH

Implementation of the SEITT approach has been going on in the nine education provinces of Zimbabwe since 1998. Concurrent with this implementation, an evaluation study was carried out between 1998 and 2000. This chapter is a report of that study. Section 5.1 introduces the study. Section 5.2 presents the design of the study, including the general approach to the study, sampling, data collection, and analysis procedures. Section 5.3 presents the results of a cross-case analysis of the implementation of the SEITT approach in the three provinces. Each sub-section ends with tentative conclusions. Section 5.4 concludes the chapter.

5.1 RATIONALE

From chapters two and four the reader will recall that the SEITT approach had five components that RTs were required to implement in the provinces, namely *PCK workshops*; *curriculum materials writing*; *networking*; *research*, and *running SMCs*. When the SEITT approach entered phase II, the second and final phase of SEITT, there was a consolidation phase specially designed to prepare provinces for withdrawal of external funding. Consequently, this phase emphasised the sustainability of the programme. This emphasis added *fund raising* to the number of executable provincial activities. SEITT only contributed enough money to run two workshops per year. RTs in each province had to raise enough money to implement the rest of their action plan. RTs were also being taught planning skills. In this area, RTs were expected to produce comprehensive annual action plans in which was laid out the annual agenda for the provincial professional development programme. Consequently, this evaluation added annual *action plans* as the seventh item of evaluation. Fund raising and annual actions plans will be referred to as preconditions to implementation of the SEITT approach.

With regards to action plans, provinces were supposed, as a minimum requirement, to include elements of the SEITT approach. This had been agreed to by MoESC

and SEITT. Each province, however, was allowed a certain leeway to include in their action plans those activities they considered essential, provided they advanced the teaching of science and mathematics.

This study is not a comprehensive evaluation of the entire nine provinces in which SEITT operated, but is instead a case study of three selected provinces. The study was carried out over a period of three years, with data gathering done towards the end of each year. Where possible the same subjects were interviewed throughout. This study is, therefore, a longitudinal case study (Krathwohl, 1998; Stake, 1995; Yin, 1984) in three selected provinces. In doing this evaluation, the study focuses on how resource teachers (RTs) and science and mathematics centres (SMCs) implemented the seven action points of the SEITT approach. Attention is also paid to the way the environment of the RTs influenced RT operations.

5.2 DESIGN OF THE STUDY

5.2.1 AIM AND QUESTIONS OF THE EVALUATION

The evaluation of the SEITT approach aimed at studying the implementation of the seven action points of SEITT. The study also aimed at studying the way the environment influenced the implementation of the SEITT approach. The following research questions were used to specify research activities:

For the two preconditions, the following questions guided the research:

1. *What was the quality of action plans drawn up by each of the three provinces?*
2. *How successful were provinces in fundraising to implement their action plans?*

For the five elements of the SEITT approach, the following question guided the research:

3. *How were the following components of the SEITT approach implemented?*
   - *i. Pedagogical content knowledge (PCK) workshops;*
   - *ii. Curriculum materials writing;*
   - *iii. Networking;*
   - *iv. Research;*
   - *v. Science and mathematics centres.*

The SEITT approach was implemented in an environment, the provincial school system, that had its own physical and bureaucratic structures (see 2.2.2). The

implementation of SEITT implied the addition of further structures and bureaucracy. The implementation of the SEITT approach would therefore be influenced as the two environments negotiated for co-existence. This part of the study was guided by the following question:

4. *In what ways did the environment of RTs influence implementation of the SEITT approach?*

5.2.2 SELECTION OF CASES AND DATA SOURCES

CASE SELECTION

In order to select the most informative cases, criteria for case selection were used. A province was suitable for inclusion in the study if it met the following criteria:

1. A reasonable SMC had been established;
2. A management committee (MC), with expected composition (see section 2.4.3), had been set up and already active;
3. At least one meeting between teachers and RTs had been held to inform the teachers about the provincial programme. Holding such a meeting was an indicator of functional RTs.

Applying the first criterion, two out of nine provinces were disqualified. These provinces had not yet offered accommodation for SMC. Applying the second criterion to the remaining seven eliminated one province. Applying the last criterion dropped three out of the remaining six provinces. The remaining three provinces were therefore considered the most active, and hence became the sample provinces. These three provinces are Matabeleland North (MAT), Manicaland (MAN), and Mashonaland Central (MASH). Table 5.1 shows the characteristics of these three provinces. The information pertains to what the provinces were like at the beginning of the study.

Table 5.1
1997 outlook of the provinces involved in the evaluation

Province	Typical environment	Number of schools in province	Urban to rural school ratio	Approximate number of teachers served
MAT	Urban plus rural	19	3:1	114
MAN	Urban plus rural	17	1:3	102
MASH	Rural	7	1:7	42

Although the sample for this research is not meant to be representative of the population, the information in Table 5.1 was considered necessary to provide the reader with an idea of the numbers and types of schools in the sample provinces as well as the

number of teachers who participated in SEITT in the sampled provinces. Nationally there were 70 A-level schools based in urban areas and 57 in rural areas. From Table 5.1, and after some calculation, it becomes clear that the sample had 19 schools (with 114 teachers) based in urban areas and 24 schools (with 144 teachers) in rural areas. The sample therefore includes more schools and more teachers based in rural areas compared to the respective number of schools and teachers based in urban areas.

DATA SOURCES

The following section identifies sources of information and provides a justification for the choices made.

- *Resource teachers (RTs)* were involved in every aspect of the SEITT approach's implementation. For this reason they constituted a major source of data for this study. In three of the provinces already selected, the three most active RTs in the programme, two representing science and one mathematics, were chosen. Selecting the most active RTs in the programme was considered likely to yield the most data. Identification of the three was facilitated through researcher observations and advice from fellow university lecturers involved in SEITT. For the three provinces, there was thus a total of nine RTs earmarked for interviews.
- *Education officers (EOs)* constituted the second major source of information. EOs were considered important for three reasons. First, they represented the provincial administration in the program. Secondly, they were part of the collegial implementation team through their participation as members of the local MC. And thirdly, outside the SEITT program, they served as education officers responsible for the teaching of the very subjects SEITT was trying to improve. Each of the two SEITT subjects, science and mathematics, has one EO each per province, and these two EOs were included in the sample.
- Although *school heads* were not major players in the actual implementation of the SEITT approach, they were considered important sources of information since they influenced the release of and transport for teachers to professional development activities. Furthermore, for the school heads of SMC host schools, they had explanations related to SMC infrastructure and accessibility. The school head of the SMC host school and one other school head—already chosen by other schools to represent them on the MC—were considered adequate choices for the sample. Altogether 6 school heads were earmarked for interviews.
- Each *provincial director* was included in the sample because they understood and interpreted policy issues within their province as well as facilitated EO participation in SEITT in their respective provinces.

- *Teacher views* concerning the usefulness and effect of workshops were important. Therefore, all teachers attending workshops were to be included in sample. Also interviewed were two teachers per province who frequently attended workshops or other meetings where teachers were invited. Workshop attendance registers were used to identify such teachers. Table 5.2 provides an overall count of the sample for this study.

Table 5.2
Respondents for the three cases

	Case			
Data source	*MAT*	*MAN*	*MASH*	*Totals*
RTs	3	3	3	9
EOs	2	2	2	6
School heads	2	2	2	6
Teachers for interviews	2	2	2	6
RD	1	1	1	3

5.2.3 DATA COLLECTION

Data for the study was collected through a number of methods, which are outlined in Table 5.3. The table matches the five components of SEITT and the two preconditions (see 5.2.1) with data collection methods.

Table 5.3
Components of the SEITT approach and data collection methods

	Method		
Research theme	*Interview*	*Observation*	*Document analysis*
Action plans	✓	✓	✓
Fund raising	✓		✓
PCK workshops	✓	✓	✓
Curriculum material writing	✓	✓	
Networking	✓		
Research	✓		
SMCs	✓	✓	✓

INTERVIEWS

In this study, interviews were used as the major method for data collection. The interview questions were organised around the five components of the SEITT approach. Box 5.1 shows the themes (in bold) around which the questions were asked and includes, as an example, one of the questions that was asked in each of these categories (Appendix C1-C3 has all three interview schedules).

Box 5.1
Sample question under each component of SEITT in interview guide

a.	**Program of activities** *Which activities on your action plan have you carried out? Why?* (or specifically why was some particular activity not carried out?)
b.	**PCK workshops** *How are you translating workshop ideas into the classroom?*
c.	**Curriculum materials writing** *Have you carried out any materials writing workshop(s)? How successful was it?*
d.	**Networking** *How successful was your computer workshop?* (if action plan indicates that it was done).
e.	**SMC** *How accessible is your SMC?*
f.	**Research** *Did you carry out any research this year? In what area?*

Across these interview categories the three interview guides (see Appendices C1-C3) were organised around the same issues and asked similar questions depending on which group of respondents the question was directed to. This facilitated triangulation. Under programme activities, for example, the question asked applied specifically to RTs, and hence was asked only to RTs. Under PCK workshops, the question applied to both teachers and RTs, and hence is found in both interview guides.

Interviews were clustered between August and October, a period after which there were no SMC activities since teachers and other school personnel were busy with end of year examinations. All three provinces were visited during this time and the same[1] respondents interviewed each time. Consequently, each earmarked interviewee was supposed to be interviewed up to three times in the three years. This intention was not always met since some teachers dropped out for various reasons, or were not always available at the time they were supposed to be interviewed. Table 5.4 shows that not all interviews were carried out, except with teachers. In all cases, interviews were conducted by the researcher and were tape-recorded. The final interview count is indicated in Table 5.4.

[1] An MAT deputy provincial director had to be interviewed in place of the provincial director. Twice, different teachers, one in MAT in 1999 and one in MAN (2000), had to be interviewed due to the unavailability of the original teachers.

Table 5.4
Interview count between 1998 and 2000

Interview category	Total number of interviewees	Total number of interviews
Resource teachers	9	21
Education officers	6	14
Teachers	6	18
Heads of schools	6	14
Provincial directors/DRDs	3	4

OBSERVATIONS

Observations were done to collect information related to the way RTs conducted particular activities. Activities that the researcher had opportunity to observe are indicated in table 5.3. Six workshops in MAT (two every year[2]), two in MAN (one in 1998 and one in 2000), and one in MASH in 1999 were observed. Workshop observation scheduling was complicated by the fact that cases tended to organise workshops mostly during the second week of school vacations—mid April and mid August. This restricted the number of observations that could be made, due to clashing timetables. Observed activities all related to pedagogical content knowledge (PCK) workshops. A detailed copy of the workshop observation guide is found in Appendix C4.

DOCUMENT ANALYSIS

Table 5.5 identifies some major documents produced by SEITT and indicates the kind of information that was obtained from them. Information pertaining to the structuring of SMCs and other relevant occurrences was recorded in the form of field notes. Such information was categorised under the same themes as those used with interviews.

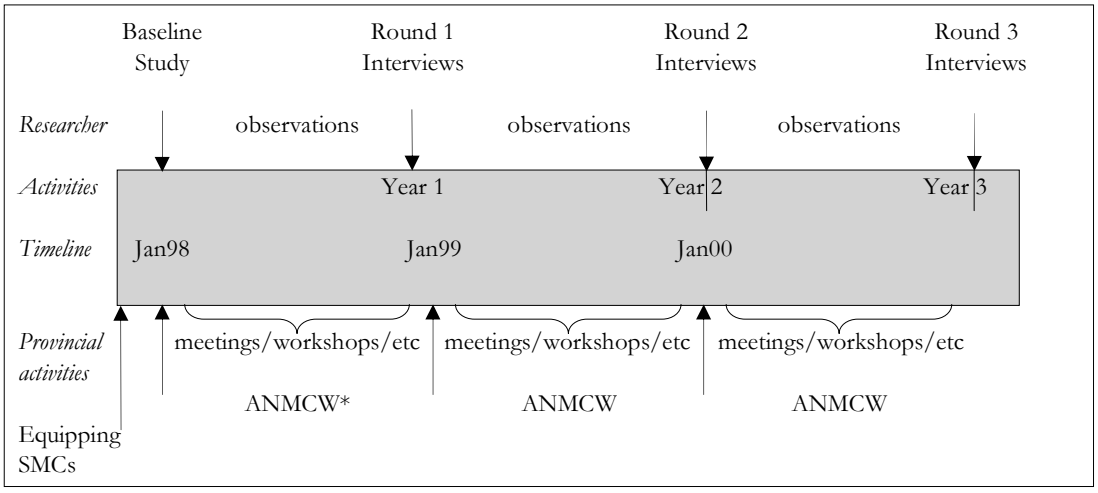
[2] More workshops were observed in MAT because the researcher was the co-ordinator for that province and hence had more opportunities to make observations.

Table 5.5
Use of major documents produced by the SEITT project

Document	Information extracted
Proceedings of the ANMCs[3] workshop (1999, 2000)	Action plans, fund raising issues, implementation constraints
Provincial co-ordinators' reports	Activities in particular cases, especially on workshops researcher would have failed to observe.
SEITT conducted decentralisation study report (1995)	Ideals of SEITT
MC minutes	Activity planning, stakeholder involvement, implementation of activities, financing of activities.
RT prepared workshop action plans and completed workshop evaluation forms	Supplementary data to workshop observations.
SMC visitor's logs	Frequency of SMC use

The timeline in Figure 5.1 shows particular events of SEITT along the implementation trajectory. It also shows the positions along the trajectory when data were collected. The methods used for data collection are included.

5.2.4 OVERVIEW OF RESEARCH EVENTS AND TIMELINE



Note: * ANMCW = annual national management committees workshop.

Figure 5.1
Research activities between 1998 and 2000

The top part of Figure 5.1 shows the activities of the researcher, in particular the positions along the continuum where the various data were collected. The bottom part of the figure shows implementation activities within the province.

[3] ANMCW = Annual national management committee workshop.

5.2.5 DATA REDUCTION AND ANALYSIS

This section presents information on how the data for this study were processed. In all data reduction discussions and the rest of the dissertation, the reader is referred to the world-wide-web where all data tables have been deposited. Data files have been labelled with a DB prefix. The URL is http://projects.edte.utwente.nl/crc/seitt-eval.

INTERVIEWS

Table 5.6

An example of the outcome of data reduction (1998 interviews)

Degree of implementation of action plan	**RTs** *(n=3)*	**Head of SMC host school** *(n=1)*	**Education officers** *(n=2)*	**Result**
AGM held	3 agree	agrees	2 agree	All agree AGM was held
MC meetings held	3 agree	agrees	2 agree	All agree MC meetings were held
PCK workshop held	3 agree	agrees	data missing	RTs and head agree PCK w/shop held

After the tapes were transcribed, interview responses were clustered according to the various areas of research. These areas of research fell within one of the five components of the SEITT approach. This clustering was maintained throughout the data reduction process (Miles & Huberman, 1994) by way of summaries. When a response was made by more than one interviewee per category, a bracketed number was utilized just after the best phrase representing that response. Responses to corresponding questions were also arranged by category of respondent, making it clear what each group said on a particular issue. Table 5.6 illustrates how this was done (for complete data table, consult DB5.2.1 to DB5.2.3, DB5.3.1 to DB5.3.3 and DB5.4.1 to DB5.4.3).

Table 5.7

An example of the outcome of data reduction for teacher interviews

CMW in	**1998** *(n=2)*	**1999** *(n=2)*	**2000** *(n=2)*	**Result**
MAT	2 say no CMW done. Handouts given	2 say one CMW done plus handouts	2 say 1CMW done	No CMW in 1998 but one each in 1999 and 2000. Handouts given

Teacher interviews were similarly treated, the emphasis being placed on what the teachers said from year to year, and hence the columns showed the years 1998, 1999, and 2000 instead. This facilitated a progressive view of ideas and activities to see if they were changing from year to year. Table 5.7 shows an example of the outcome for this data reduction process. A complete set of completed data tables is found in the following data bases: DB5.2.4, DB5.3.4, and DB5.4.4.

OBSERVATIONS

Observation of workshops resulted in a number of filled out observation inventories. For each observation, frequency counts were made for each observation issue and recorded depending on whether the issue was checked present or absent. The most frequently checked items were interpreted as the most prevalent practice. For materials writing, field notes were used to get a general picture of how this exercise was being carried out.

DOCUMENTS

The proceedings of ANMCW published provincial action plans and fundraising successes and constraints, among other issues. Extracted action plans were analysed according to quality criteria as discussed in 5.2.1. Details of fundraising activities were extracted from reports made here and compared by province (see 5.2.2).
RT and co-ordinator reports–summaries of activities carried out per province–were extracted and placed under the relevant component of SEITT, as explained for interviews.

5.3 RESULTS

Presented in this section are the results of implementation of the two preconditions of SEITT (*action plans* and *fund raising*) and the five components of SEITT (PCK workshops, curriculum material writing, networking, research, and SMCs) as well as the environmental factors influencing SEITT approach implementation. The result tables from which the within-case and cross-case analysis has been done have been deposited[4] in the following website: http://projects.edte.utwente.nl/crc/seitt-eval/. Presentation of results follows the order in which the seven components were presented in subsection 5.2.1. To facilitate comparison, the intentions of SEITT are

[4] This action was meant to reduce the amount of description, thus reducing the size of this chapter, but at the same time has reduced the readability of the chapter.

first stated. This is followed by the results, after which a comparison between SEITT intentions and implementation findings is made. A tentative conclusion is made before the next issue is presented.

5.3.1 QUALITY OF ACTION PLANS

Research for the assessment of action plans was guided by the following question:

What was the quality of action plans drawn by each of the three provinces?

Quality criteria for assessing action plans were derived from SEITT expectations about the implementation of each component of the SEITT approach. An action plan was considered of good quality if it:

a. Incorporated all five components of SEITT.
b. Planned for at least six workshops in each year (two workshops per term).
c. Contained sufficient detail to guide implementation such as: 1. Activity (topic or theme); 2. Objectives and/or expected outcomes of the activity; and 3. Date on which the activity was to be performed.
d. Was sensitive to the continuity of events in a manner that facilitated change. The following would constitute indicators to this sensitivity: 1. PCK workshop should be followed immediately by curriculum materials writing activity or workshop; 2. Setting up of a curriculum materials writing group; 3. A series of related workshops.

Table 5.8 shows a year-by-year summary of how the components of SEITT were included in the action plans.

Table 5.8
Summary data from action plans with respect to inclusion of SEITT components and fundraising

	1998			**1999**			**2000**		
Components / **Provinces**	***MAT***	***MAN****	***MASH***	***MAT***	***MAN***	***MASH***	***MAT***	***MAN****	***MASH***
Fundraising	–		✓	✓	✓	–	✓		–
PCK workshops	✓2		✓2	✓2	✓1	✓2	✓3		–
Curriculum materials writing	–		✓1	✓3	✓2	✓4	–		✓4
Networking (Including IT)	–		–	–	–	–	–		–
Research	–		–	–	–	–	✓		–
Computer workshop	✓1			✓5	✓2	✓1	✓2		✓1

Key: (–) means item not included in action plan; ✓means item planned for; following number specifies frequency of that activity; blank means data was not available.

Note. *Data for MAN for 1998 and 2000 were missing. The action plans were evidently produced but their whereabouts could not be ascertained.

INCLUSION OF COMPONENTS OF THE SEITT APPROACH

Data in Table 5.8 shows that no single case planned for every component of the SEITT approach in a single year. The three-year pattern result (in the absence of MAN) shows low inclusion of activities (six altogether) in 1998, a relatively considerable increase (22 altogether) in 1999 and lower (10) in 2000. Curriculum materials writing workshops (14 workshops) were the most planned for, followed by PCK workshops (12 workshops) among the components of the SEITT approach. Research was least planned for whilst networking was not included at all by any of the cases throughout the entire three years.

These results show that not all components of the SEITT approach were included in action plans for each year. And even more, networking was not planned for throughout the three years by all provinces, with only one province planning for research in 2000.

INCLUSION OF OTHER ACTIVITIES

Besides the components of the SEITT approach, action plans also indicated that all regions had planned for computer workshops (where teachers and some RTs were taught how to use the machines). MAT had planned for five computer workshops in 1999, a number significantly larger than the other two since they thought they needed that many to gain the necessary skills. They could also afford it. Besides computer workshops, some activities unique to individual cases–end of year practical setting[5] workshop in MAT, a common mid-year examination exercise in MAN and MASH, and school visits in MASH–were included in action plans.

SIX WORKSHOPS PER YEAR

SEITT had intended that each province implement two workshops per term for three terms in a year. For all three cases, that would translate to 18 workshops per year.

[5] A-level biology, chemistry, and physics are partly examined through a practical examination. Teachers often need help in interpreting the advance instructions and setting up the required materials.

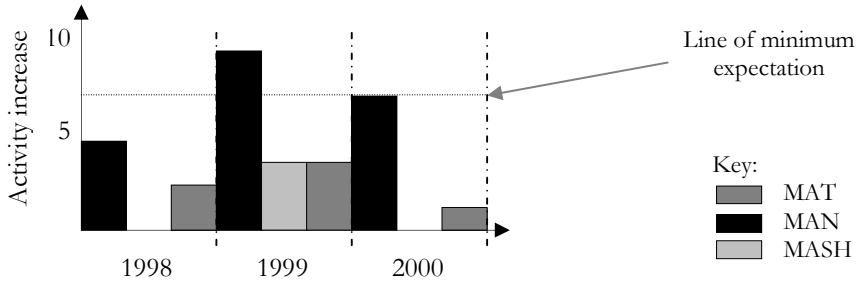


Figure 5.2
Pattern of activity numbers over 3 years

The activity pattern is shown graphically in Figure 5.2. This clearly shows that there was a low frequency of activities in 1998, a comparatively high increase in 1999, and a reduction in 2000. In 1998, in the absence of data from MAN, both provinces failed to meet this criterion when workshops for PCK, and computer and workshops additional to the SEITT approach were aggregated. In 1999 and 2000, MAT conducted a total of eight and six workshops, respectively, when the practical examination-setting workshop was included, with the other two provinces failing to meet this criterion. MASH again failed in 2000. Interviews, however, indicated that doing workshops in the third term was not practical since most A-level teachers were too busy in their schools to attend workshops. This SEITT expectation, therefore, proved impractical in the prevailing school circumstances.

SUFFICIENCY OF ACTION PLANS IN GUIDING IMPLEMENTATION

Action plans tended to be sketchy. Although two of MAN's action plans (1998 and 2000) were missing, their 1999 action plan was sufficiently informative, whilst MAT and MASH action plans only showed the dates and theme of workshops but left out objectives, and hence did not meet this criterion.

SENSITIVITY TO CONTINUITY OF EVENTS

The plans lacked such detail that in all planned for PCK workshops, it was not possible to determine the content of either the workshop or the subsequent activity. In MASH action plans, curriculum materials writing was based on a different theme from that of the previous PCK workshop.

Looked at over the three-year period, the following conclusions–specific to each criterion–were made:

a. Action plans did not incorporate all the components of SEITT as expected. This happened throughout the three-year period. PCK workshops and CMW activities seemed preferable to the other activities, with networking ignored altogether.
b. One out of the three provinces met this criterion, but only in the last two of the three years. Whilst two workshops per term in the first two terms was considered practical, doing two workshops in the third term was considered impractical since teachers are busy preparing for practical examinations, preparing students for examinations, and marking national examinations.
c. The MAT and MASH action plans were insufficiently clear to guide transparent implementation whilst the results for MAN, in the absence of the other two plans, were inconclusive.
d. Action plan items were not specific enough with regards to what was actually to be done in that PCK workshop or CMW activity. This made it difficult to link topics for curriculum materials writing with preceding PCK workshops. In the MASH plan, where enough detail was provided, there was no linkage between the PCK done and the CMW that followed.
e. RTs did not limit themselves to activities within the SEITT approach but also planned for activities they considered most urgent and important. Computer workshops were such activities. This outcome, however, shows that SEITT had not sufficiently considered the preparedness of teachers (including RTs) for some of the activities they were expected to carry out. This outcome will be discussed in more detail in chapter seven.

5.3.2 SUCCESS OF FUNDRAISING

Research for the assessment of fundraising was guided by the following question:

How successful were provinces in fundraising?

A province was considered successful in fundraising if it met the following criteria:

a. *Raised at least $48,000 per annum*. This amount was enough to run six workshops (at $8,000/workshop), two a term for three terms. This criterion was found most practical to judge the success of fundraising since workshops constituted the most expensive item in the action plan of each province.
b. *A permanent source of funding*. This was a sustainability issue, and hence provinces had to appeal to a funding source that was capable of meeting the centres' annual budget every year, thus ensuring continuity of professional development in that province.

Table 5.9 shows the amounts of money each province was able to raise on a year-to-year basis for the three-year period.

Table 5.9
Funds raised between 1998 and 2000/number of workshops that could be sustained by the funds raised

	Pledge per school per year	**Net collected* from schools per year/ (number of workshops possible)**		
	(in Zimbabwe $)	*1998*	*1999*	*2000*
MAT	10 000	- (0)	152 000 (19)	156 000 (19)
MAN	1 500	7 500 (1)	10 500 (1)	0 000 (0)
MASH	11 000	77 000 (10)	51 000 (6)	15 000 (2)

Note: * Some schools failed to meet their pledge (promise) in full and hence the varying amounts collected. Some increase from year to year was due to an increase in the number of A-level schools in the province.

Figure 5.3 shows a pattern of funds raised over the three-year period by all three provinces.

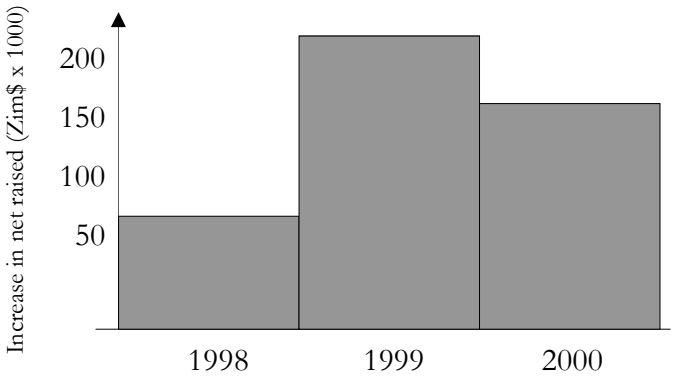


Figure 5.3
Pattern of funds raised between 1998 and 2000

RAISED AT LEAST $48,000 PER ANNUM

Over the three-year period, MAT failed in 1998 but succeeded in 1999 and 2000. MAN failed throughout, whilst MASH succeeded in 1998 and 1999 but failed in 2000. The results pattern suggests there was generally more fundraising for all three provinces in 1999, which was sustained in MAT on through to 2000. Compared to each other, MAT and MASH schools had pledged at very high rates that ensured success in the event that schools paid up their pledges. MAN pledges on the other hand were so low that even if all schools paid in full, they would successively fail to raise enough money to mount more than three workshops per year. From Table 5.8,

schools responded differently to paying up, with MAT and MASH on the one hand indicating high response rates whilst MAN failed to reach 50% in any one year. The situation of RTs in their respective provinces is discussed in the following paragraph.

MAT spent 1998 explaining their programmes to schools, teachers, and SDAs. Consequently, in AGM of January 1999, school heads and their SDA representatives offered to peg the pledges at the amount indicated. The response rate by SDAs/SDCs was subsequently high. MASH, on the other hand, had taken advantage of a DRD who was particularly interested in the SEITT approach, and therefore lobbied schools on behalf of the MC. This explained the high success rate in 1998. The DRD moved out of the province in 1999 and schools stopped paying. MAN had problems within its MC, leading to poor information dissemination to schools and the provincial director. According to the then resident RT, schools had not been convinced of the necessity for fund raising.

A PERMANENT SOURCE OF FUNDING

All three cases used the forum of the annual general meeting to talk to school heads and their School Development Associations and/or Committees (SDAs/SDCs). SDAs/SDCs are permanent organisations which have income dedicated to improving schooling for their children (see 2.2.3).

Compared to the success criteria over a period of three years, the following conclusions were drawn:

a. None of the provinces managed to meet the success criteria continuously. The results also suggest that this criterion could be met for as long as the need was clearly communicated to SDAs/SDCs. From the results, three levels of success are discernible: sustained success, opportunistic success, and outright failure. Sustained success was associated with a comprehensive programme of information dissemination, whilst opportunistic success was linked with utilisation of favourable opportunities whilst they existed. The latter strategy proved to be unsustainable in the case of MASH. Failure by MAN appeared to be associated with an incoherent management committee that made information dissemination difficult.
b. SDAs/SDCs are permanent school funding entities. Hence, being able to access funding from these sources meant all three cases had managed to appeal to the most sustainable source.

5.3.3 PEDAGOGICAL CONTENT KNOWLEDGE (PCK) WORKSHOPS

This section presents results focusing on the way PCK workshops were implemented. The section seeks to answer the following research question:

How was the pedagogical content knowledge workshop component of the SEITT approach implemented?

Through these workshops, SEITT intended that each province achieve the following:

a. In addition to other activities, *mount at least two PCK workshops per term* in the first two terms of each year (= 4 PCK workshops per year);
b. Presenting teachers with *opportunities to learn pedagogical content knowledge* in new areas of the syllabus;
c. *Sharing of information among teachers* in homogeneous subject groupings (biology, chemistry, mathematics, and physics workshops);
d. *Generating content for curriculum materials writing*, and;
e. *Involvement of subject experts* in workshops.

MOUNT AT LEAST TWO PCK WORKSHOPS PER TERM

PCK workshops constituted 4 out of 6 workshops that SEITT expected from each province per year. The other two workshops could pertain to other issues. The results are shown in Table 5.10.

Table 5.10
Number of expected, planned, and implemented PCK workshops per year

	1998			**1999**			**2000**		
PCK workshops	*MAT*	*MAN*	*MASH*	*MAT*	*MAN*	*MASH*	*MAT*	*MAN*	*MASH*
Expected (by SEITT)	4	4	4	4	4	4	4	4	4
Planned	2	?	2	2	1	2	3	?	0
Implemented	2	0	2	2	1	2	3	2	2

These results show that none of the provinces over the three-year period reached the number of expected workshops. The results also suggest that provinces aimed at implementing what they had on their action plans rather than what they were expected to implement. This statement, however, cannot be made with certainty in the absence of MAN action plans for 1998 and 2000.

RTs gave the following reasons for their failure to meet the criterion:

- In 1998, they (RTs) were mostly busy trying to adjust to their new roles and expectations, and as a result called for a limited number of workshops.
- In 1999, MAN said they had no money to mount more than one workshop since SEITT had not provided them with any money for that year, and what they had was just barely sufficient for the particular workshop they did mount (see Table 5.10).
- MAT and MASH cited time as the major reason for failing to mount more workshops, even though they could afford to mount more.

In conclusion:

- All three provinces failed to mount four PCK workshops per year throughout the three years as per SEITT intention.
- Implementation followed their action plans rather than SEITT intentions.
- Time was a constraint for all three provinces, with MAN experiencing a further constraint of financial resources.

OPPORTUNITIES TO LEARN PEDAGOGICAL CONTENT KNOWLEDGE

Results of interviews with teachers over the three-year period are found in (DB5.1.4, DB5.2.4 & DB5.3.4). These results indicate the following about PCK workshops:

- Workshops in all three cases over the three year period were acknowledged to address new syllabus areas, or those areas identified by teachers as difficult to teach;
- In all three cases teachers perceived learning a lot by attending these workshops. Teachers from MAT exemplified such learning by citing the end of year practical examination setting workshop, whilst those in MAN emphasised the learning that resulted in sharing content knowledge as well as discussing methodology issues among themselves.
- Teachers gave examples of workshop activities where they actually constructed models and discussed these in relation to teaching and learning, focusing also on the advantages and disadvantages of using such models. That way they were involved in learning subject content and evaluating strategies for teaching and learning. Two such examples were observed by this researcher and are presented in Box 5.2.

Box 5.2
Examples of interactive PCK workshop activities (1999)

A biology activity
Teachers created models of DNA using paper cuttings and pasting these onto Manila paper to create wall charts that they took to their schools. After creating such models in the workshop, teachers discussed the effectiveness of such modelling for teaching purposes, including possible misconceptions that might arise in students.

An example in physics
After teachers had been introduced to some never before seen electronics kits developed in Zimbabwe, they were afforded the opportunity to use the kits to do some projects described in the manual. Teachers were later provided with electronic components from which they developed a kit each to take to their schools

These results indicate that PCK workshops were viewed (by teachers) as addressing their content (subject) needs and improving their teaching methodologies. Teachers also viewed them as relevant since all the work covered was within the syllabus requirements for their teaching.

In a post workshop questionnaire, teachers were asked to specify what they thought they had learnt in both subject content and teaching skills. Teachers listed a whole range of specific content and skills (see DB5.5.1 & DB5.5.2). Teachers could therefore identify new knowledge and skills they thought they learnt from these workshops. These results are consistent with what the interviewed teachers said throughout the three-year period. Results on teacher satisfaction with PCK workshops are included in Appendix C5. These results indicate that the level of teacher satisfaction with PCK workshops was high. Although it is acknowledged that the results are overly optimistic, which shows the weakness of questionnaires, these results are useful as an indicator of the level of teacher satisfaction with the content of PCK workshops.

The following conclusions concerning PCK workshops are drawn:

- PCK workshops presented teachers with opportunities to interact with subject content and discuss ways to teach for learning with understanding.
- Teachers indicated that they left PCK workshops with new knowledge and skills. PCK workshop content was valued by teachers. Subject content knowledge and teaching skills acquired were also perceived so useful that teachers predicted improvement of their teaching as a consequence of these workshops.

SHARING OF INFORMATION AMONG TEACHERS

The decentralisation study (Ncube & Engels, 1995) had diagnosed teacher isolation as part of the problem teachers faced and which accounted for some of the poor teaching habits. As part of its strategies, SEITT provided opportunities (through workshops) for teachers to share and learn from each other. Such sharing occurred at PCK workshops as teachers discussed their classroom experiences, an opportunity afforded them as part of the activities in PCK workshops.

Generally, interviewed teachers found sharing in PCK workshops a valuable source of learning, suggesting that they recognised each other's knowledge as valid and worth utilising. The extracts from interviews (see DB5.2.4 –DB5.4.4) in Box 5.3 provide comparative findings among the three cases.

Box 5.3
Teacher views concerning sharing in PCK workshops (n =2)

MAN teachers
……. We learn a lot when we share among ourselves (2)* …….The RT makes very good suggestions. Ours (RT) often highlights some of our experiences and suggests others should try them too. …. I wouldn't come if RTs just lectured to us. ……There were really no opportunities for them (RTs) to mess up since we did all the discussions in groups. …… (DB5.2.4).

MAT teachers
…… RTs bring some innovative ways of teaching some topics. Teachers also bring lots of interesting ways. We learn from each other a lot. The practical exam preparation workshop is very useful for all teachers (2). We share mostly ideas about how to obtain the required materials. In chemistry, we discuss a lot about preparation of the necessary chemicals (2). Some (ideas) are however not directly usable in class. They need some modifications due to differences in the kind of apparatus we have. We need to discuss more ideas from the students' perspective …… (DB5.3.4).

MASH Teachers
…. There was lots of teacher discussions (2). We are learning a lot from the RT as well.
There wasn't enough time to discuss issues in depth (2) ……. We discuss a lot among ourselves. … (DB5.4.4).

Note: * The number of RTs out of a total of three (in each province) who made the statement is included after each statement. Where a number is not included, the reader should interpret that to mean one person said it. All phrases referring to sharing were extracted from each interviewee and aggregated between interviewees.

Throughout the three years of the project (1998-2000) teachers were consistent concerning the strategy used by RTs of getting them to share teaching ideas and experiences (DB5.2.4-DB5.4.4). The sharing was mostly focused on discussing subject matter and teaching ideas and skills. In the year 2000 (DB5.3.2), one of the three MAT RTs said teachers wanted a shift towards discussing student work and

activities, as this would facilitate a link between workshops and classroom teaching. MAN teachers recognised sharing among themselves as important for learning and did not change their ideas about this. MASH teachers also acknowledged sharing among themselves as a source of learning PCK. Teachers in MASH considered sharing among themselves as more valuable than direct presentation by their RTs.

Sharing among teachers went beyond workshop scenarios. In 1999 in MAN (DB5.2.4), a group of schools set a common midyear examination for their schools and marked scripts for each other's classes. Although this happened in only one subject, teachers and school heads in these schools appreciated the new co-operation among their teachers, with one school head saying that it brought new experiences to students. In MAT (DB 5.3.1, DB5.3.3), teachers responsible for setting up A-level practical examinations helped each other interpret instructions and source materials for the examination. Teachers who attended these workshops (from workshop evaluation reports) rated them as informative, practical, and made setting up of practical examinations easier. The two EOs involved explained their popularity by citing their immediate applicability.

The following conclusions are drawn:

- Sharing among teachers was facilitated through PCK workshops, examination setting workshops, and practical setting workshops. Teachers perceived a great deal of learning through sharing.
- Throughout the three years of this research, teachers continued to value the sharing approach. Although MAT teachers wanted a change of focus in their workshops, from teacher-centred to student-centred, they still wanted discussion among teachers to be the mode of information acquisition.
- The focus on the use of sharing in PCK workshops by the three provinces would suggest that this intention of SEITT was being achieved.

GENERATING CONTENT FOR CURRICULUM MATERIAL WRITING

Through this, SEITT expected RTs and teachers to discuss and even receive lectures on subject content and teaching methods in those areas teachers found difficult. Interviews and observations of workshops indicate that outside subject and pedagogical experts were not called in to facilitate at PCK workshops. Instead, teachers discussed and generated content for CMW among themselves.

INVOLVEMENT OF SUBJECT EXPERTS

In general, none of the three cases involved experts from industry or subject experts from university to facilitate in PCK workshops as SEITT had intended. RTs, however, do not appear to have ignored the SEITT advice but instead had their own ideas concerning how this aspect could be implemented. When asked for explanations, RTs (in all three cases) said they first looked among their own experienced teachers or among their body of RTs for volunteers to lead a particular workshop before they looked for outside help. They only brought in outside help when they could not do it themselves. Only two activities were facilitated by outsiders—one in MASH where teachers received a talk by the local examinations' council (ZIMSEC) expert on examination setting and marking (DB5.4.3), and the other in MAN where the school head of the SMC host school was the resource person for the two computer workshops.

Compared with the intentions of SEITT, the following conclusions are made:

a. There was a general failure by all three provinces to mount four PCK workshops each per year. The reasons for this failure to reach SEITT targets varied: cases first implemented what was in their action plans (which was less than expected); MAN experienced finance problems; and both MAT and MASH experienced time constraints.
b. PCK workshops run by RTs provided teachers with opportunities to learn pedagogical content knowledge.
c. The objective to provide teachers with ample opportunities for sharing information during PCK workshops was met. Teachers valued this, especially when they were exposed to sources of information they considered important for teaching and learning.
d. Whilst some content was generated during PCK workshops, it was not systematically used as intended since materials were hardly written.
e. The objective to get subject experts (from university, teacher training colleges, and industry) to lead PCK workshop presentations was not met. RTs preferred a different plan in which they first considered expertise among themselves and other teachers before looking outside the teacher body. For this reason, RT thinking on this issue was at variance with that of the project.

5.3.4 CURRICULUM MATERIALS WRITING

The evaluation of this aspect of the SEITT approach was guided by the following question:

How was the curriculum materials writing component of the SEITT approach implemented?

The SEITT project document states that curriculum material writing (CMW) was incorporated into the SEITT approach as a means of producing concrete materials to facilitate the transfer of PCK workshop discussions into materials usable by teachers at classroom level. To make this happen, SEITT had developed a procedure that required the following:

a. *Every curriculum materials writing activity to be associated with a PCK workshop;*
b. Writers' group to *convert PCK workshop discussions into teaching materials;*

The above two intentions of SEITT were used as the criteria for assessing CMW. For the purpose of this evaluation, learning about problems related to curriculum material writing was also important, and hence the addition of the following fourth aspect:

c. *Problems with CMW workshops.*

Every PCK workshop is associated with a curriculum materials writing workshop

Table 5.11 shows the number of planned and implemented CMW workshops. The shaded row that shows the number of implemented PCK workshops has been included to facilitate comparison between implemented CMW and PCK workshops, as the two were expected to correlate.

Table 5.11
Number of planned and implemented CMW workshops

	1998			**1999**			**2000**		
CMW workshop	*MAT*	*MAN*	*MASH*	*MAT*	*MAN*	*MASH*	*MAT*	*MAN*	*MASH*
Planned	0		1	3	2	4	0		4
Implemented	-	-	-	1	1	-	1	1	1
Implemented PCK workshops	2	0	2	2	1	2	3	2	2

It is clear from this table that implementation of CMW workshops was very limited. There was no CMW workshop in all three provinces in 1998, two provinces held one each in 1999, and three held one workshop each in 2000. The one-to-one link between CMW workshop and PCK workshop does not exist. The MAT RT, however, explained this low implementation by pointing out that the one workshop in 1999 was held to prepare all teachers for the CMW, to discuss the nature of the materials, and then to obtain volunteers for the writing process. After that workshop, four writing teams (biology, chemistry, mathematics, and physics) continued the activity in a non-workshop environment. Therefore, what appears like non-implementation in the MAT case could be misleading.

In the three-year period, 14 out 16 PCK workshops used an observation guide that sought to investigate whether RTs showed a relationship between one workshop and the preceding one during the course of the PCK workshop observed. Such relationships included feedback to the RT concerning the level of teacher success in implementing ideas from previous workshops in their classrooms. Observation of handouts was important as these materials, written before the workshop, appeared to be replacing CMW, thus defeating the purpose of CMW. This related directly to CMW since these materials were expected to capture such ideas and help teachers operationalise them in their classrooms. The table also shows actions taken by RTs that encourage or show that a CMW activity was going to succeed the workshop. Results of these observations are shown in Table 5.12.

Table 5.12
Observations of curriculum material writing related issues at PCK workshops (DB5.6)

Item number	**Observation item** *(n = 14)*	**Yes (%)**	**No. (%)**
8	Discussions of successes and failures in applying previous workshop ideas	3	21
24	CMW groups set up	2	14
25	CMW group members allocated tasks	2	14
26	CMW program set up	2	14
30	RT/resource person issues handouts	14	100
31	Previous CMW group progress discussed	2	14

The results show that, on average, only in two out of 14 workshops did RTs refer to issues where CMW related issues were raised during PCK workshops. RTs for MASH cited time constraints during PCK workshops to introduce CMW, since most of their teachers were based in rural schools. These teachers wanted PCK workshops to break early so that they could catch buses back to their rural schools. Three MAN RTs claimed that writing was reserved for CMW workshops. In MAT, four writing teams had been previously set up and were in the process of completing the previously given writing assignment, which, one year after it was started, was taking too long to complete.

These results and the reasons for them suggest poor planning in the MASH case. Since the province was made up of rural schools, teachers wouldn't even start the exercise, since they were always be in a hurry to catch buses back to their rural areas. The reason given by MAN and MAT suggests that they had deviated from the SEITT intention. Even though MAT had writing groups, there were so many subjects to write on that more groups could have been formed. Given the findings

in chapter four, that RTs perceived inadequate preparation for CMW, the lack of preparation for CMW appears less related to the reasons given by RTs in all three cases. Such results also suggest poor monitoring on the part of SEITT staff since CMW was a very important activity for the success of the SEITT approach, especially its aim to improve classroom level teaching and learning.

In conclusion:

- There was no relationship between the numbers of planned (even implemented) CMW activities with the number of PCK workshops within the whole implementation period. Because the SEITT intention was not followed hence the implementation of this aspect of the SEITT approach failed.

CONVERT PCK WORKSHOP DISCUSSIONS INTO CURRICULUM MATERIALS

As indicated already, much of this did not happen as SEITT expected. The general practice over the three-year period was to use at classroom level the workshop notes taken by individual teachers or handouts made by RTs prior to the workshop (see DB5.2.4; DB5.3.1; DB5.4.4). Using such notes was not what the SEITT approach had in mind. The two MAN workshops (1999, 2000) were dedicated to the writing of examination materials, which though relevant, were one-off activities that did not help improve teaching skills and enhance learning. The fact that this activity was done by chemistry RTs and their teachers, but not by teachers in the other three subjects, suggests a fragmentation of the approach to project implementation in MAN, a reflection also of poor project administration by the MC in that region. However, one province, to some extent, followed the SEITT expectation for CMW. Their procedure is outlined in the following paragraph.

In MAT, two PCK workshops, one in biology and the other in physics, were observed on the same day in 1999. For each group, the writing content was based on the materials generated during the same workshops (mathematics and chemistry also set up similar structures but were not directly observed). Both groups enlisted volunteer writers from among the teacher lot including one RT per group. Biology writing focused on subject content since this was a new area in the syllabus whilst the physics group focused on techniques and skills that students were expected to gain and display in practical examinations. Writing content was divided into portions with each writer choosing a portion from which to base their writing. Several follow ups of this writing process (in all four subjects) showed that it went on for the rest of 1999 and was still not complete by end of 2000. Draft materials were produced in

both cases, but the procedure appeared to break down at classroom level where RTs claimed feedback from trials was not forthcoming from classroom teachers.

In conclusion:

- The SEITT intention to convert PCK workshop content into teaching materials was not generally met. Only one province converted PCK discussions into curriculum materials, as expected, but even then failed to complete the process.
- Notes made prior to the PCK workshop by RTs, or those taken down by participants during PCK workshops, were used by teachers instead. This practise generally meant that workshop discussions were not captured and synthesized into formal teaching materials, but rather individual interpretations of workshop proceedings found their way into the classroom.
- Where post PCK workshop writing occurred, PCK workshop discussions were converted to teaching materials by a team of writers. But the procedure took too long and could not be completed. Where the procedure was not followed, the materials were produced for a different purpose than improving teaching and learning.

PROBLEMS WITH CMW WORKSHOPS

Collected over the three-year period, the following problems were cited as influencing the implementation of CMW:

- Time factor: MAN and MASH failed to organise CMW workshops as post PCK activities. They offered the reason that teachers had to leave early to catch buses back to their rural stations. Whilst such excuses were reasonable, RTs could easily have foreseen such a problem and planned accordingly. To cling to this explanation for three years would suggest a lack of interest or inability to carry out the process. Bullet two gives a more substantive reason. In MAT, RTs cited lack of time to make effective follow ups of the writing and subsequent collections of feedback. Curriculum materials writing, though organised during workshops, was done by individuals during their spare time. RTs and teachers complained of lack of such time due to full teaching timetables (DB 5.3.1; 5.3.3; 5.4.1; 5.4.3).
- Lack of writing skills: RTs had already indicated in chapter four that their training for materials writing was inadequate and hence they lacked confidence in their ability to write or supervise such an activity. They cited delays in training (in the field as promised by SEITT) as a contributory factor to the delay of launching their provincial CMW programs. Lack of monitoring by SEITT as well as the failure to provide necessary skills in a timely fashion led to this situation.

Compared with the intentions of SEITT, the following conclusions are made:

a. The results with respect to the first intention of SEITT over the three year period show that provinces had abandoned the SEITT procedure to attach a CMW activity to a particular PCK workshop. They preferred, in the few cases when writing occurred, to combine the discussions of a number of PCK workshops into one CMW activity or to raise a writing activity out of the need to affect a particular event, such as the setting of examinations.
b. The results with respect to the second criterion of SEITT over the three-year period show that RT workshop notes and/or teacher-made notes during PCK workshops became the dominant materials for transfer to classroom level. The low frequency of compliance with this criterion is therefore a general indication of the failure of the CMW strategy.
c. RTs, including other teachers, generally had full timetables, and therefore could not find time to write curriculum materials. This process appears also to have been impeded by the lack of RT skills in writing curriculum materials. The possible lack of supervision of provincial activities by SEITT and its failure to provide timely, on-the-field training in writing skills could further explain such a failure.

5.3.5 NETWORKING

Research on networking was guided by the following research question:

How was the networking component of the SEITT approach implemented?

In the document of the SEITT project, the element of networking was included in order to remove teachers from their isolation. Networking was to be implemented through the following strategies:

a. *Regular meetings of subject groups* to discuss subject related issues;
b. *Production of a SEITT magazine and provincial newsletters;*
c. *Communication via e-mail and the Internet.*

These three SEITT components constituted the criteria for assessing implementation of this aspect of SEITT. The environment also appeared particularly important to electronic communication, especially when RTs in their action plans appeared to emphasize computer knowledge. Learning about problems related to the Internet was also important, and hence the addition of the following third aspect:

d. *Problems with the Internet.*

REGULAR MEETINGS OF SUBJECT GROUPS

Interviews with RTs and teachers indicated that meetings of subject groups did not occur because these groups in all three cases had not been formed. RTs said that they were too busy in their other teaching duties to initiate these.

PRODUCTION OF SEITT MAGAZINE AND PROVINCIAL NEWSLETTERS

The intention of SEITT was to produce a national magazine at least once a year, depending on the availability of teacher contributions. Each SMC was expected to produce periodic newsletters that also captured classroom level teaching innovations by teachers. The results of this aspect of SEITT are as follows:

Only one SEITT magazine was produced in 1998 and distributed nationally. The editor cited lack of article contribution by teachers as the major reason why other issues of the magazine in 1999 and 2000 were not produced. MASH produced and circulated one newsletter to all their teachers, also in 1998, but not after that. The interviewed RTs (two) in MASH claimed that teachers did not contribute materials; therefore the newsletter became just an RT mouthpiece for announcing coming workshops. Since these were not many either, a letter of invitation served the purpose and was cheaper to produce. MAN and MAT did not produce any newsletters, citing the only and simplistic reason that they did not get around to doing it. The lack of success of this aspect of networking could indicate that SEITT, after making the correct diagnosis of the problem (teacher isolation), had made a poor choice of treatment. This could also indicate a lack of interest in writing on the part of teachers as well as the ubiquitous time problem. It should also be noted that the SEITT mother body also produced one newsletter and then stopped. This did not set a good example about the need for regular communication with teachers, which could also explain the failure of the process at the provincial level.

COMMUNICATION VIA E-MAIL AND THE INTERNET

Periodic inspection of the electronic log of sent and received items indicated that in all three provinces over the three-year period, the resident RTs accessed e-mail and the Internet whenever their system was running. In MAT, also, the two laboratory technicians accessed the Internet. In general, other RTs did not access the net, mostly because they taught at schools other than the SMC and were not regulars at the SMC. Teachers generally did not access the net. Interviewed RTs advanced three reasons for this state of affairs: first, most teachers were not computer literate; second, MCs had not opened the medium to teachers due to fear of large telephone bills; and thirdly, most teachers found SMCs inaccessible.

Interviews also show that RTs attempted to improve the computer literacy of teachers by scheduling computer workshops prior to running the electronic network. Results (see Table 5.8) show that a number of such workshops had been included in respective SMC action plans. Very few of these workshops actually took place (two mounted in MAN and facilitated by an SMC school head). The problems with establishing computer networks were clearly articulated by RTs. These are outlined in the next paragraph.

PROBLEMS WITH THE INTERNET

Three major problems related to computer based networks emerged. First, the level of computer literacy was very low among teachers and RTs. As such computer literacy was considered a prerequisite for networking to take place. The second problem related to the unavailability of computer equipment to facilitate the essential training of teachers in computers in order to improve literacy. This problem mostly explains why MAT and MASH did not mount these workshops. The third problem arose because of the unavailability of direct telephone lines, especially between 1998 and 1999. SEITT confirmed the problems in facilitating such connectivity, especially due to the difficulties of securing direct telephone lines for SMCs. MAT SMC shared a line with the SMC host school through a parallel connection, making it extremely difficult for the SMC to access the line during normal working hours. In 2000, all three provinces had secured direct lines for their SMCs and were therefore much better able to log onto the net. The use of this facility was, however, still closed to teachers in general because MCs insisted they needed to put mechanisms in place to enable the telephone bill to be met. This was particularly so in MASH, which had to dial to Harare to connect. This implied a long distance call each time a teacher logged onto the net, making the system expensive to operate.

The problem with networking in general is that RTs preferred electronic networking, of which they themselves (including their teachers) did not have adequate computing pre-requisites, and they also had to operate in areas ill-suited to support this. An interview with the SEITT co-ordinator responsible for networking revealed that SEITT had expected networking via subject groups, magazines, and newsletters to progress smoothly. The non-implementation of this aspect, therefore, came as a surprise. Problems with electronic networking had been anticipated, but a start was considered necessary since the ability of teachers to use IT would facilitate a wider network with the world than the localised solutions of magazines and newsletters. This discussion will be pursued in chapter seven.

Compared with the intentions of SEITT, the following conclusions are made:

a. Teacher networks through subject group meetings did not take place due mostly to the non-existence of these groups.
b. One out of at least three magazines produced and distributed at national level and one newsletter produced by one province, all in the first of the three years of SEITT, is an indication of failure of this aspect of SEITT. This resulted from a possible poor diagnosis of teacher need by SEITT.
c. Electronic communication (by e-mail) only operated to a very limited extent, mostly involving resident RTs, and in one region, also technicians. Failure to adequately train teachers in computer literacy, infrastructural difficulties, and equipment inadequacy limited the viability of electronic networks.
d. The attempt to effect Internet communication was hindered by computer illiteracy, unavailability of sufficient computers, and inadequate telecommunication infrastructures to facilitate connectivity.

5.3.6 RESEARCH

This aspect of the study was guided by the following research question:

How was research, as a component of SEITT, implemented?

Research in the SEITT approach was considered an important means of identifying teacher needs as well as providing feedback to the various areas of implementation of the SEITT approach at provincial level. Consequently, RTs were expected to do the following research activities:

a. *Need analysis research* on a yearly basis;
b. *Workshop evaluation research;*
c. *Classroom research* to determine effectiveness of interventions.

NEED ANALYSIS RESEARCH

RTs in all three provinces indicated doing need analysis research to determine teacher needs. Interviews with RTs and SMC documents indicate that two sets of need analysis research were done by all three provinces, first in 1997 (DB5.1) and in 2000 (DB5.3.3, DB5.4.3). Although the research starts in 1998, RTs used needs as indicated by the 1997 research to plan activities for 1998. From this research, RTs prioritised problem teaching areas and used these as a basis for PCK workshops in subsequent years.

Compared with SEITT intention, RTs did not do need analysis research every year as expected. This research was done twice instead of three times. The reason for skipping one year of the research, namely that the 1997 research provided enough data for a two-year action plan, appeared reasonable.

WORKSHOP EVALUATION RESEARCH

SMC documents indicate that all 16 PCK workshops and five CMW workshops implemented over three years were each evaluated in terms of data gathering via workshop evaluation questionnaires. A standard questionnaire was used in all three provinces. This questionnaire was issued at the end of every workshop, filled out immediately by teachers, and then collected by RTs. There was no indication anywhere to suggest that RTs came together to analyse and discuss workshop evaluations. Each RT reacted to teacher comments as they saw fit. Nevertheless, RTs indicated that teacher comments enabled them to improve subsequent workshop organisation and presentation. All this seemed to happen at an informal level.

Compared to the set criterion, RTs performed workshop evaluations as expected, but the usefulness of the data appeared minimal since formal data analysis of these evaluations did not occur.

RESEARCH IN CLASSROOMS

Research meant to improve teaching practice had not been done. RTs linked this latter part of the research with the DSME research project that was supposed to involve RTs in investigating the effect of the professional development program. Due to this linkage, RTs had not by themselves initiated this aspect of their work. Considering that CMW had not occurred, there were no materials available in classrooms to do research on.

Compared with the intentions of SEITT, the following conclusions are made:

a. Need analysis research done in 1997 and 2000 appeared to meet the information needs of RTs for planning purposes, even though they did not meet the SEITT intention of having this done every year.
b. Evaluation of workshops was done after every workshop as expected but lacked the requisite formal analysis to make such research serve the purpose for which it was intended.
c. RTs had not performed this aspect of research on the understanding that it was supposed to have been initiated by SEITT co-ordinators on a collaborative basis with RTs and teachers.

5.3.7 SCIENCE AND MATHEMATICS CENTRES (SMCS)

Research on the development and use of SMCs was guided by the following research question:

How were SMCs, as a component of the SEITT approach, implemented?

The following SEITT ideals were used as criteria for evaluating the development and use of SMCs:

a. *A venue for workshops*;
b. *A source for reference materials*;
c. *A communication centre*;
d. *A meeting place for teachers;*
e. *A centre for the stocking and distribution of curriculum materials written within the project.*

Management committees were further mandated to develop their SMC to suit the needs of their specific provinces. As such, the sixth criterion constituted a record of further development. A case was considered successful if it improved on any of the above criteria or added an extra use of the facility, backed by the necessary inputs. This sixth criterion is stated as:

f. *Development of SMC.*

Table 5.13 provides a summary of the results of this aspect of the SEITT approach. Some variations and explanations are subsequently given.

Table 5.13
Overview of the implementation of SMC functions

	1998			1999			2000			
SMC function	*MAT*	*MAN*	*MASH*	*MAT*	*MAN*	*MASH*	*MAT*	*MAN*	*MASH*	**Results**
Venue for workshops	✓*	✓	✓	✓	✓	✓	✓	✓	✓	Successful
Source for reference materials	LTD*	LTD	LTD	LTD	LTD	LTD	LTD	LTD	LTD	Partially successful
Communication centre	*x**	*X*	*x*	LTD	LTD	LTD	✓	LTD	LTD	Partial success
Meeting place for teachers	LTD	LTD	LTD	LTD	LTD	LTD	✓	LTD	LTD	Partial success
Centre for stocking & distribution of curriculum materials	*x*	*X*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	Unsuccessful
Further development	*x*	*X*	*x*	*x*	*x*	*x*	✓	*x*	*x*	Unsuccessful
Accessibility	LTD	LTD	LTD	✓	LTD	LTD	✓	LTD	LTD	Partial success

Note:* LTD indicates limited success, ✓ indicates success, *x* indicates unsuccessful.

A VENUE FOR WORKSHOPS

Results in all three cases throughout the three years indicated that SMCs were used as workshop venues for all scheduled workshops taking place at the SMC host school. The school venues for workshops were considered ideal because science workshops were often hands-on and thus required laboratory facilities. Due to competition for laboratory space, SMC host schools in all three provinces preferred SEITT workshops to take place on Fridays, weekends, or during school vacations. Teachers, on the other hand, considered weekends non working days whilst school vacations were not ideal for all teachers since they were considered to interfere with individual holiday plans.

In conclusion:

- SMCs served as workshop venues throughout the three-year period as had been intended by SEITT. These venues were, however, inflexible with regards to the periods when workshops could be held.

A SOURCE FOR REFERENCE MATERIALS/A MEETING PLACE FOR TEACHERS

All three SMCs were equally stocked with reference materials. Interviews revealed that RTs in all cases used the SMC resources to access information and to use it to prepare workshop handouts. Classroom teachers found the resources (see inventory list in section 2.4.1) useful but the access logistics difficult. As mentioned by teachers in all three cases, distance, time, and transport costs for regular access to these materials were prohibitive. In MAN and MASH, teachers resorted to having the host school laboratory technician copy and send materials requests by post. Such materials did not always arrive on time. Table 5.14 shows trends for the drop in rates of teachers between 1998 and 2000. The log records did not indicate the purpose of each visit recorded, as it was not possible to desegregate between the criteria B/ and D. The logs also show that SMCs experienced large numbers of visitors during scheduled workshops. This is the time when most teachers accessed reference materials, a time that was considered untimely since scheduled workshops were few and far between.

Table 5.14
Average monthly teacher visits per SMC as shown in visitor logs

	MAT	**MAN**	**MASH**
1998	20	12	9
1999	32	12	9
2000	92	12	9

Interviewed teachers (as well as the resident RT) in MAT attributed low visits in 1998 and 1999 to the inaccessibility of the SMC host school as well as poor SMC accommodation and facilities for such meetings. The accessibility of the relocated centre in 2000 as well as the employment of a full time SMC administrator accounted for the average increase in the number of visits to the SMC. The average for MAN and MASH, at 12 and nine respectively, was due to the inaccessibility of the centres since most schools (see Table 5.1) making up the membership of the two SMCs were rural. Formal workshop attendances have not been considered in this analysis.

In conclusion:

- The reference materials were considered useful and necessary for running workshops as well as for teaching by both RTs and teachers. But teachers, especially those from rural schools, found the materials inaccessible since it required much travelling, and hence too much time and money spent trying to access these materials. As a result, rural teachers failed to use these resources regularly.

A COMMUNICATION CENTRE

SMCs served as communication centres (sending and receiving e-mails, telephone, and address for all SMC activities) to a limited extent due to reasons already cited in section 5.3.5. In 1998, for instance, there was limited communication since the e-mail facility had not yet been installed. After the installation of e-mail/Internet, poor telephone lines in 1999 accounted for limited use. Even after most problems had been solved by 2000, it was mostly RTs who used e-mail to communicate with other RTs and SEITT co-ordinators at the University of Zimbabwe. Such communication was not frequent (as evidenced by outgoing electronic log registers of sent messages). Given the above, the intention of SEITT to facilitate teacher communication by electronic means, and hence facilitate fast communication had very limited success during the three years of data collection[6]. SMCs did not therefore operate much as communication centres.

A CENTRE FOR THE STOCKING AND DISTRIBUTION OF CURRICULUM MATERIALS

This function of SMC was included in anticipation of a stock of materials generated by the curriculum materials writing exercise. SMCs did not serve this function since materials had not been produced.

DEVELOPMENT OF SMC

The MAT SMC did not register any growth between 1998 and 1999. According to the EO and resident RT, accommodation at the old centre was not suitable, security for materials was poor, and there were accessibility problems. These problems prompted the MC to relocate the SMC to a site in the centre of Bulawayo. The new renovated centre had a dedicated room for computers, a library, RT office, reading room, and reprographics room. Adjacent to this SMC was a MoESC boardroom that was also available for MC meetings. The MC employed a full time housekeeper and put in place a roster for RTs to 'man' the centre in the afternoons. The MC met the transport costs for RTs. The MC had managed to add over a thousand books and an additional four computers to their basic stock. MAT had therefore succeeded in expanding their infrastructure, equipment, and library. The MAN centre continued without a dedicated room throughout the three years and did not register any growth. Although MASH had suitable accommodation for the SMC, it did not, like MAN, grow.

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[6] This observation was only correct for MAT during the period of data gathering. In 2002, a visit showed the SMC now operated as an Internet café with teachers queuing to use e-mail. Teachers were mostly using this facility to apply for jobs outside Zimbabwe, a situation necessitated by politics and inflation.

Compared with SEITT intentions, the following conclusions are drawn:

a. All PCK workshops took place at SMC host schools. As far as hosting workshops was concerned, SMC venues were successful.
b. SMCs stocked reference materials that RTs and teachers could use. Due to limited accessibility of the SMCs, the criterion to act as a source for reference materials was only partially met.
c. The criterion to make SMCs communication centres was only partially met. The SMCs did not have adequate infrastructure, especially in the first two years, to fully support this objective.
d. Generally teachers did not find SMCs convenient venues to rendezvous for an occasional school-related meeting because these centres were either too far or out of the way for most teachers. The year 2000 situation in MAT was an exceptional case, but it also indicated the potential for the SMC to meet this criterion.
e. Curriculum materials were not written during the three years of research; therefore it was not possible for the SMCs to support this intention.
f. The criterion was generally not met since only one out of three centres managed to develop both its infrastructure and improve its relevant inventory.

5.3.8 FACTORS THAT INFLUENCED IMPLEMENTATION OF THE SEITT APPROACH

This subsection was guided by the following research question:

In what ways did the environment of RTs influence implementation of the SEITT approach?

Emerging from RT interviews and interviews of other stakeholders and observations, there were recognisable factors that influenced implementation of the SEITT approach.

Factors that had a positive influence on implementation were:

a. Partnerships with EOs;
b. Pressure and support (support of the SEITT approach by key stakeholders);
c. Addressing perceived needs of teachers.

Factors that had a negative influence on implementation were:

d. Time;
e. Incentives;
f. Financial compensation.

The ways in which the six factors influenced implementation of the SEITT approach are discussed below.

PARTNERSHIPS WITH EOS

Particularly evident in MAT, both EOs participated fully in MC, not as EOs but as colleagues in all workshops that were run by RTs in that province. Programs such as fundraising and the development of SMC were successful, including improved workshop attendance (DB5.3.3). Teachers felt this afforded them the opportunity to talk informally to their education officers, as opposed to meeting them only during official inspection business, a situation that was often intimidating. In MAN, one EO took RTs along during school visits, in what would normally be termed purely EO business. RTs appreciated that, and so did the schools they visited. Through such participation by EOs, RTs felt encouraged, supported, and promoted by their authorities. Still, there was no noticeable visibility of the EO science and maths in MASH SMC affairs.

In conclusion:

- *Partnerships with EOs* motivated RTs in their work (MAT and MAN), resulted in teachers attending professional development more often (MAT), and appears to have led to increased implementation of programmes (MAT).
- When EOs did not actively participate, (such as in MAN and MASH) programme implementation was slowed.

PRESSURE AND SUPPORT

When the supportive DRD in MASH was still around, school heads attended AGM meetings and subscribed generously to the SMC fund (DB 5.4.2). The same was not true after he left. In MAT, the support of professional development by RD and his EOs enabled the province to secure spacious accommodation, identify funds to renovate, and secure co-operation by school heads and SDAs/SDCs to generously fund professional development. In MAN, where such support was minimal, the MC had problems with fundraising. At no time did teachers ever state that they had problems with being released to attend professional development activities. Throughout the three years, not one case reported a failure to hold a scheduled workshop due to lack of authorisation by the MoESC hierarchy.

In conclusion:

- Where senior authority actively and practically supported professional development, it was easier for RTs to organise workshops and mobilise resources (raise funds and get the support of schools and parents) to facilitate implementation of their programs. Failure to accomplish as much as SEITT intended was due to reasons other than lack of facilitation by senior authorities.

ADDRESSING THE REAL NEEDS OF TEACHERS.

PCK workshops addressed the needs identified by teachers, and did so in a manner recognised by teachers as helping them learn new content areas. Teachers particularly enjoyed the sharing of PCK among themselves. SEITT also provided most recent textbook titles as reference materials at SMCs that were not available in their schools. Although this advantage did not translate to increased visits to SMCs, efforts to access such materials suggested that teachers valued and needed this resource.

In conclusion:

- Teachers will respond positively (through attendance) to professional development that addresses their real or perceived needs.

TIME (DB5.2.1; DB5.3.1; DB5.4.1)

For MAT, the time to organise workshops was seen as the only major hurdle standing between them and increasing the number of workshops required to meet expected SEITT minimum levels. Although not achieved by the end of 2000, the resident RT still insisted that if they were facilitated through workload reduction, RTs would have sufficient time to meet and thereby exceed the minimum number of workshops per year (DB5.3.2). This RT position was supported by the school head and the EOs. MASH RT added that SEITT had robbed him of the time he used to have for his family. Time constraints contributed to shortened workshop time in provinces with rural schools (mostly MAN and MASH). Essential activities therefore failed to take place.

In conclusion:

- RTs were not facilitated, through workload reduction, to implement SEITT related activities. Such time constraints accounted for the reduced implementation of the SEITT approach.

INCENTIVES

MoESC promised RTs at the beginning of their training that they would receive an extra salary notch as soon as they graduated and a reduced teaching load for all SMC resident RTs. MoESC did not implement these two promises throughout 1998 and 1999 (DB5.2.1; DB5.3.1; DB5.4.1). RT reaction to both cases of MoESC procrastination was exemplified by the mathematics RT in MAT who refused to associate with the programme until these two conditions had been met. The programme in MAN was also affected (DB4.1 Q24 answers). This point was directly related to the failure by MCs to provide travel finances for RTs to attend meetings and help run SMC.

Therefore:

- Adding duties to teachers that are not normally associated with teaching, and failing to pay teachers for rendering such services, had negatively impacted implementation of the SEITT approach through reduced implementation of activities, lowering of the morale of RTs, and a reduction in the number of RTs willing to implement the program.

FINANCIAL COMPENSATION

Although workshops were organised, failure to provide RTs with travel allowance during the organisation of workshops resulted in limited RT participation. In MAN, the resident RT was left to do most of the organising alone. Other RTs would only come on the day of the workshop (see DB5.2.1, DB5.2.2, DB5.2.3). MASH RTs also cited this problem (see DB5.4.1). In MAT, the problem existed in 1998 and 1999 when the centre was still at its old location. Once relocation had been effected, MC provided RTs with a transport allowance, even one to come and run the centre in turns during afternoons. During the time this problem existed, RTs suggested it lowered their morale (see. DB5.2.1, DB5.4.1). Therefore:

- Failure to finance RT travel expenses incurred during organisation of workshops leads to reduced labour for the organisation of activities as well as reduced implementation of activities.

5.4 CONCLUSIONS

This chapter presented the results of the evaluation of the SEITT approach's implementation by RTs in three provinces over a period of three years. The evaluation focused on the ability of RTs to produce annual action plans, raise funds to implement their action plans, and implement the core of the SEITT approach.

The findings indicate that RTs made an effort to implement all seven action points of SEITT. Such implementation tended to be lower than expected in all three provinces and throughout the three years of the study. The findings also indicate a mixture of success and failure, as well as show a pattern in the profile of implementation over the three years when activities started–low key in 1998, increased relatively considerably in 1999, and slightly reduced in 2000.

The ability of RTs to plan for transparent implementation of annual programs over the three-year period was lower than hoped for by the project. Generally, RTs produced plans that were not as detailed as expected and included less of what was expected. Such plans also included what RTs considered more urgent for their provinces even though such activities were outside core SEITT expectations. Ability to raise funds differed between provinces, ranging from consistent failure by one province to consistent success by another. Success or failure in fundraising seemed related to the coherence of the MC running that centre and the amount of information that the MC provided to the prospective funding organisation.

Although implemented PCK workshops were fewer than expected, teachers in all three cases valued their content and perceived content in these workshops as powerful enough to change both their PCK and teaching skills. Such workshops helped teachers to interact with materials and share teaching ideas with RTs as well as among themselves. RTs failed to implement as many PCK workshops as they had planned due to time and financial constraints. Consequent and subsequent to PCK workshop implementation, RTs in all cases and over time failed to link each PCK workshop with a CMW activity. In the single case where the activity was attempted as expected, there was general failure by all subject groups to complete the exercise. Whilst such a failure was attributed to a lack of time for monitoring and follow-up by respective RTs, results elsewhere in this report suggest that RTs were inadequately trained to successfully implement this exercise. As a result, there were fewer CMW activities, with the few of those started but not completed. In the

absence of such materials, the project preferred mode of PCK idea transfer to classroom teaching differed from what actually happened on the ground and was therefore a deviation from the project intentions. The evaluation findings also point to the limited success of the networking component of the SEITT approach. Networking through magazines and newsletters failed because teachers did not submit articles. Electronic networking on the other hand, although patronised at low levels compared to project expectations, established infrastructural points that had a potential to act as nuclei for bringing teachers to the information age. One province had already taken off in this direction a year after observations for this study had ended. The general failure of the electronic aspect of networking was blamed on a general lack of computing skills by teachers, the large distances between SMCs and potential users, and the precarious financial position of MCs with respect to their ability to pay the resultant telephone bills. Two out of three aspects of research (though small) had been attempted, but even then, not done as rigorously as expected. Absence of curriculum materials that carried project ideals made research at classroom level not worthwhile.

Findings also point to the fact that SMCs had a facilitating effect as intended by SEITT. The location of some SMCs posed such accessibility challenges that the use of SMC facilities was confined mostly to SMC host school teachers, with the rest accessing the facility during scheduled workshops. The other challenge resulted from the lack of reliable telephone lines. This aspect limited the use of SMCs as communication centres thus limiting the operation of this aspect in the first two years of the study. The MC of one out of the three SMCs under study managed to develop the SMC way beyond the basic project provision while the other two failed to do so. Findings also show that the involvement of EOs as RT colleagues in managing the SMC programs and the involvement of influential stakeholders (MoESC senior management and parent organisers) facilitates project implementation.

In summary, it can be said that RTs met with limited success in implementing the SEITT approach. The findings indicated that RTs were able to fundraise, organise and run PCK workshops, and do need analysis research and workshop evaluation. The findings also indicated that RTs were partially successful in the preparation of action plans, and to a very limited extent, CMW. Results also show that RTs generally had problems implementing the networking aspect of SEITT, due mainly to a lack of computer skills among teachers and the difficulty of operating an

electronic network in an unconducive environment. RTs were affected in their operations by low morale and motivation due to undelivered promises by MoESC and perceived insufficient training in some roles, especially in CMW. Improved performance could also have been achieved had RTs received adequate guidance, monitoring, and feedback by their university colleagues. The failure of the CMW and research programmes appears related to the fact that their University colleagues had promised to provide more on- the-field training with regard to CMW and collaboration with regard to research. These two promises had not been fulfilled during the period of this research.

- 6 -

EVALUATING OF CLASSROOM IMPLEMENTATION OF A PHYSICS MODULE

This chapter describes the design and evaluation of Contextualised Learner-Centred Teaching (COLECT) materials. Section 6.1 positions this chapter with respect to findings in other chapters and the basic aims of SEITT. Section 6.2 describes the curriculum materials used in the COLECT study. The design guidelines and the role of the curriculum materials are also included in this section. Section 6.3 presents the questions and methods for the evaluation of the physics module. Results are presented in section 6.4 whilst conclusions for the chapter are stated in section 6.5.

6.1 INTRODUCTION

In chapter three it was concluded that the Science Education In-service Teacher Training (SEITT) approach had high potential from a theoretical perspective. However, the evaluation study (chapter 5) showed that the implementation of the SEITT approach was problematic in most areas. Among the problematic areas were curriculum materials writing by RTs and teachers at the provincial level. Failure to produce and use these materials implied that less of what teachers did at PCK workshops was being implemented at the classroom level since these transfer materials to bridge the workshop and classroom level were missing (Loucks-Horsley et al., 1998). The SEITT approach, however, did not only focus on teacher curriculum writing. It also included a more professional writing of curriculum materials at a national level. Although teacher representatives in the form of RTs were mainly the authors, they were selected at the national level and were writing as a team of experts. One set of materials, the physics module, produced through the latter writing programme is in the forefront of this study. This module focused on teaching physics in context using a learner-centred approach. The study was thus appropriately named the Contextualised Learner-Centred Teaching (COLECT) study.

As part of the SEITT approach's strategy, these materials were expected to considerably reduce teacher domination of lessons, increase the quality of teacher-student and student-student interactions, and assist teachers in implementing a hands-on approach to physics teaching, using mostly locally sourced apparatus. In this chapter, the potential of the physics module to assist the SEITT approach in achieving these outcomes is investigated. Three other modules in the subjects of biology, chemistry, and mathematics had also been produced but had not been similarly evaluated.

6.2 THE EXEMPLARY PHYSICS MODULE

6.2.1 COMPOSITION OF THE WRITING TEAM AND CHARACTERISTICS OF THE MODULE

The national writing team for the physics module was composed of three groups of people. First were the four resource teachers (RTs) who were the principal writers of the module. These four RTs were drawn from four different provinces in order to facilitate the incorporation of ideas from various provinces in keeping with SEITT's intentions. Selection for these RTs was based on knowledge of individual RTs in terms of their ability and interest as shown during the diploma-training programme for RTs. The second group comprised the researcher who acted as the team co-ordinator and another physics lecturer. These two university lecturers ensured content validity of the materials as well as advised the RT writers on methodological issues. The third one was a physics education officer. Although he did not contribute much to the actual writing process, his inclusion was seen (by the project designers) as important in legitimising the process.

This team's mandate was to design curriculum materials with the following aims (more detail on the module is offered in 6.2.3):

- teaching physics in context;
- promoting the use of local and easily available materials;
- simplifying text language;
- promoting learner-centred approaches to teaching and learning.

TEACHING PHYSICS IN CONTEXT

The topic 'waves and oscillations' was introduced by way of a story and an illustrative picture. The story and picture were chosen to represent something that students were likely to understand and a scenario that depicted something about

their local environment. It was a requirement in the new curriculum that the illustrated story not only introduce the topic but also contain sufficient ideas leading to in-depth concept investigation. At the end of the module, students are challenged to rewrite the story in scientific language. This was a way to test for understanding of scientific concepts.

PROMOTING THE USE OF LOCAL AND EASILY AVAILABLE MATERIALS

As mentioned in section 2.1.2, one of the biggest challenges in Zimbabwean A-level schools is that of marshalling sufficient resources in the way of laboratory equipment and materials to facilitate implementation of the A-level physics curriculum. In this respect, many schools, particularly government-funded schools, have financial difficulties in purchasing laboratory equipment. In writing the physics module, writers were therefore required to identify substitute equipment and materials that were locally manufactured, affordable, and easily available. Writers were not only required to identify, but also to try out and recommend materials that they knew would work. In addition, they had to provide specifications that were detailed enough to enable teachers to find such materials in their local environments.

SIMPLIFYING TEXT LANGUAGE

For the majority of Zimbabwean children, English is a second language. This often makes the understanding of imported textbooks difficult. This guideline was intended to stimulate writers to produce text that is reflective of this.

PROMOTING LEARNER-CENTRED APPROACHES TO TEACHING AND LEARNING

To promote learner-centred teaching and learning, a variety of activities that incorporated class discussions, group work, and hands-on activities were included. The module ends with a four-question review exercise followed by two examination-type questions.

The teacher's guide had comprehensive instructions concerning the list of apparatus and specifications of each item required to facilitate student activities. It also contained advice on the role the teacher had to play in facilitating student exercises. These procedural specifications were focussed on how to organise students for specific activities, the amount of time that could be spent on an activity, and key questions to ask in order to focus students and point them to the relevant theory during activities.

6.2.2 DEVELOPMENT OF THE MODULE PROCESS

Figure 6.1 shows the general process of the development of the exemplary curriculum materials and the physics module in particular.

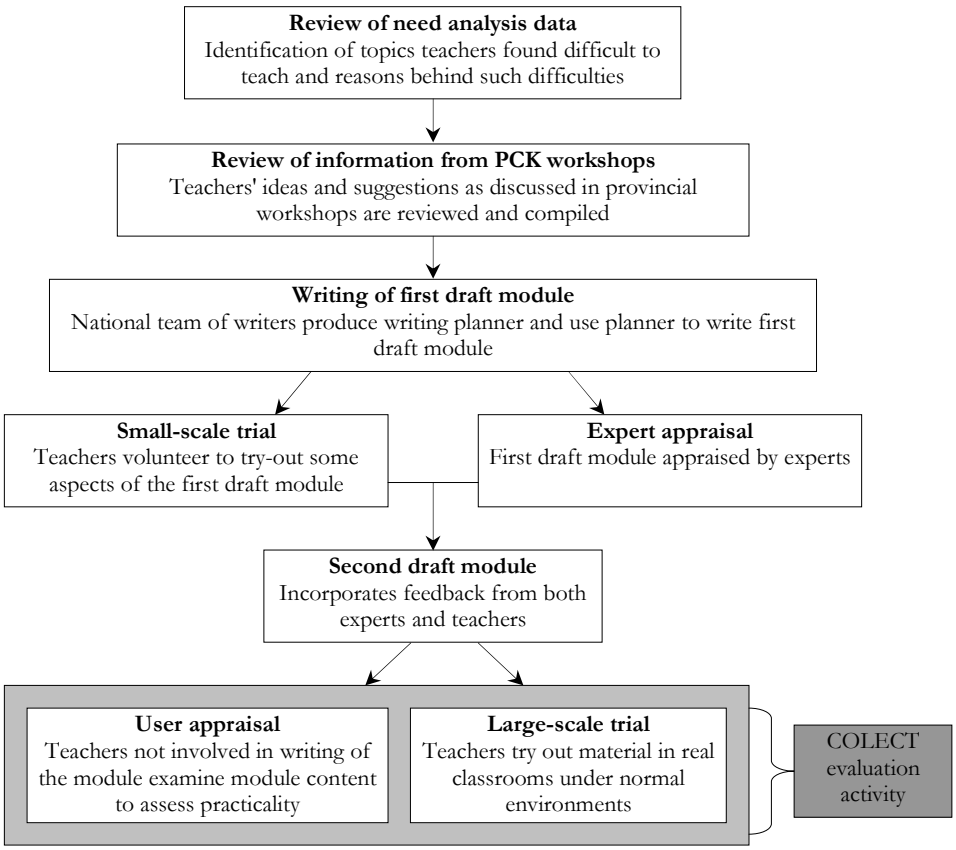

Figure 6.1
Development process of physics module

Only the bottom part of this figure is incorporated into the COLECT study. However, an overview of the previous processes offers insight into the development of these materials.

First, the national team of writers reviewed data obtained in a previously held needs analysis survey. Among the results of this research was an identification of teacher needs, including those topics that teachers found difficult to teach. *Waves and Oscillations* was one such topic.

Second, the four RTs involved in the national team had previously run PCK workshops in their respective provinces based on Waves and Oscillations. The RTs therefore came

to the national writing workshops with ideas that had already been discussed at the provincial level. This review provided the writers with those ideas and some teaching strategies that teachers felt were most appropriate for some parts of the topic. In this way, it was felt teachers had given useful input that could be put into writing.

Third, the team of writers produced a planner. This is a one-page document that carries all the information about what should go into the guide. In producing the planner, the A-level physics syllabus was used as a reference and closely followed during the writing process. An extract of the planner for the teacher's guide is shown in Figure 6.2.

Teacher's Guide Lesson: Waves and Oscillations Teaching time: One week (or five periods of 80 minutes per period) Summary description: Students will learn about Wave Generation and Propagation, Characteristics of Waves, Uses of Waves. This section is related to the following syllabus objectives: *10h*; 10i*; 10*j; 10k*; 10l**		
Activity	*Outline*	*Key points/outcomes*
Students read contextualised text	Students read about fishing—disturbance at one point being carried to another point. This introduces concept of the ripple effect (wave).	Interest generated, content related to real life experiences.
Teacher-student demonstration	Students observe a float bobbing when disturbance is at a distance. Students can be asked to produce the ripples themselves.	Pupils observe waves, skills, and techniques of doing activity practiced.
Teacher-student discussion	Students explain why float moves. Is direction of ripple the same as motion of float? How do ripples spread out? What is the height of bobbing? Number of times it moves up and down?	Energy transfer *(10l*);* Medium is stationary; Displacement; frequency *(10 l)*. Theory related to subject content linked to the activity.

Source: Proceedings of the National Materials Writing Workshop, Mushandike National Park (p.79) (Compiled by T. Mukono & E. Tambo).

Note: Numbers indicated with asterisk refer to A-level subject content objectives as they appear in the syllabus.

Figure 6.2
A framework for teacher and student planners

Fourth, the RTs and the EO did all the writing, with advice from the two university lecturers, to produce the first draft. SEITT in particular considered the method of drawing writing ideas from provincial workshops ('bottom-up') and using experts ('top-down') important since it accommodated input of teachers at a grassroots level, provided training for provincial based RTs, and facilitated ownership of the materials. This process also provided leadership, facilitation, and expertise from the

university, something that was likely to speed up the process and produce materials that were likely to be taken seriously by the Ministry of Education, Sport, and Culture and teachers. The last of these stages involved a small-scale trial in real classrooms as well as an expert appraisal of the materials. The insights generated in this process led to the revision of the first draft to produce a second draft. The five lessons in this draft are outlined in section 6.2.3.

6.2.3 THE MODULE ITSELF

The module came in two booklets: student and teacher guides. Table 6.1 provides an outline of each of the five lessons that constitute this module. Each lesson is 80 minutes long.

Table 6.1
Outline of lessons in module

Lesson	Content
1	*Contextualising content* This lesson introduces the five lesson series in this module. It offers a contextualisation scenario designed to situate learning within students' accessible or experienced environment. This lesson touches on a number of concepts that are later investigated. It acts as a reference for the rest of the lessons. Two student activities that exemplify the contextualisation scenario in a laboratory context are also included.
2	*Transverse and longitudinal waves; speed of water waves* This lesson develops the concepts of transverse and longitudinal waves. Students determine the speed of water waves.
3	*Wave concepts* This is a concept definition lesson in which teacher and students discuss wave representations. A demonstration activity using the oscillator to show phase difference is carried out and discussed. Derivation of the wave equation ($v = f\lambda$) is conducted. Students also learn the skills of experiment design.
4	*Calculations in wave theory* In this lesson, students are presented with a discussion exercise in which they illustrate the various concepts in wave motion through labelled diagrams. They are also required to solve problems by computing required quantities.
5	*Testing student understanding* Students take an individualised test in which they answer four exam type questions. Wave concepts are referred back to the contextualisation scenario. The final test of understanding is done in the form of an essay where students retell the contextualisation story in scientific language.

Figure 6.3 illustrates the first lesson in a five lesson series. Both the information for students (left) and for teachers (right) is provided. The teacher's guide and pre-lesson information for preparing lesson materials is given. More information on the module structuring is provided in Appendix D1.

Student guide

10.0 Waves

Read the story about Farai's fishing experience with grandpa which is illustrated in figure 10.1

Figure 10.1

Fishing with grandpa

"Go and sit over there", said grandpa. Farai hopped to the stone pointed at by grandpa. "Now throw your hook into the water and wait for the fish to bite". Farai followed the instructions with ease. After a very long time staring at the float, Farai became bored. The child picked up some stones and started tossing them into the water. "Stop that!", shouted grandpa. "You are scaring away the fish". "Look grandpa, the fish is now biting, the float is bobbing". After a few seconds, the float was no longer bobbing. A disappointed Farai exclaimed, "but I saw it bobbing grandpa". "Your stone, my child, your stone", said Grandpa.

Activity 1

Having read the story about fishing above, let us now look at a similar scenario. It is important that you make observations related to the water ripples and the behaviour of a float.

You will need the following apparatus:
Light coloured wide dish, pond, or swimming pool; cork/float; ripple/pulse generator; vibrator, stones, etc.

Place a float at a distance from the source of the ripples, and then generate a series of ripples as illustrated in figure 10.2

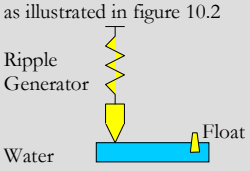

Fig. 10.2

What observations have you made related to the ripples and the behaviour of the float?
……
What conclusions can you make from your observation ……

Teacher's guide

1. Planning the lesson

For this lesson you can take the whole class to a pond if available on the school grounds or have the following materials for each group of 4 (or less) students:

- 60 or more cm dia. Plastic dish.
- Marble size pebbles
- 2 small floats (cork)
- 1 x 15cm extension spring (any that produces slow countable oscillations when a 200g mass is hung on it). Try several steel springs from your local hardware store.
- You may use a weighted plastic ball point barrel to form the weight for attaching to the spring
- Report stand or its equivalent, something with adjustable height.
- Stopwatch (student digital watches will do)

2. Lesson introduction (5-6 minutes)

Let students read the contextualising story, and discuss it with a partner(s). Allow up to 3 minutes for this activity. Mingle with students as they discuss and note some of their ideas. Do a class discussion for a further 2-3 minutes. Direct the discussion so that it does not stray much from the topic.

3. Body of lesson (60min)
(Only one of the two methods of determining period, T, is possible in this time period)

I. Let students complete and discuss activity among themselves. 1. Important observations are as follows: pulse generation; shape and movement of pulse; movement of cork relative to pulse as pulse interacts with cork

II. Let students complete and discuss activity among themselves. 2a. (you might need to demonstrate how to set up the experiment. Point out to students that reflected waves tend to complicate observations, and together work out a solution. Using a large body of water is part of the solution; surrounding experiment with something to absorb wave energy is another way.
Important concepts are as follows: periodic generation of waves; wavelength, period, T; frequency of waves, *f*; and velocity of waves, *v*;

4. Conclusions(14min)

Guide student discussion of outcomes. A set of questions aimed at highlighting the major outcomes as listed in 3II may be written on the chalkboard to guide student conclusions of lesson.

Activity 2a

This experiment is to determine the speed of water waves.

a. Write down the wave equation as studied at O-level.
b. Set up the apparatus as shown in fig 10.3. Make sure that the oscillator just touches the surface of the water

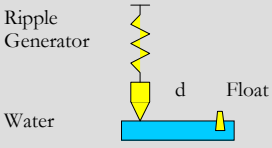

Fig. 10.3

c. Displace the oscillator so that the plunger dips into the water. Release the mass so that it makes small oscillations of amplitude ± 1cm. What happens to the cork?
d. Determine the time for 10 oscillations of the cork.
e. What suggestions can you make to improve your experiment?

Figure 6.3
Sample lesson from student and teacher's guides

6.2.4 POSITION OF THE PHYSICS MODULE

As a document that reflects intentions of stakeholders and is authored for use by teachers, the physics module constitutes the intended curriculum for that portion of teaching and learning. As such, defining curriculum and positioning this document within a curricular framework, may make it easier for the reader to understand this chapter.

As originated by Goodlad, Klein and Tye (1979), and elaborated by van den Akker (1998), the following six different curriculum representations can be discerned:

- *Ideal curriculum:* representing ideals and describing directions as desired by stakeholders.
- *Formal curriculum*: referring to proposals as approved by ministries of education and translated into documents such as school syllabi and textbooks.
- *Perceived curriculum*: referring to the interpretation by teachers of the formal curriculum.
- *Operational curriculum*: representing what actually transpires in classrooms.
- *Experiential curriculum*: representing what students actually experience in classrooms.
- *Attained curriculum*: representing what students actually learn as a result of classroom experiences.

The physics module draws from the formal curriculum (in this case the physics syllabus). In writing the module, the writers made sure that module content adhered to syllabus content. Teachers were assured of this fact and also invited to check for themselves. The module still represented the formal curriculum and shared the same platform as textbooks. This study, therefore, assumes alignment of the module with syllabus objectives and focuses on teachers' perceptions of the physics module (perceived curriculum) and how they teach using it (the operational curriculum). The study also focuses on students' thinking about their experiences as a consequence of teaching and learning using the module (the experiential curriculum).

6.3 EVALUATION APPROACH

6.3.1 AIM AND QUESTIONS OF THE EVALUATION

The aim of this study was to evaluate the relevance and practicality of the physics module in facilitating teachers and learners in classroom practices, focussing on the perceived, operational, and experiential curriculum.

The following research questions guided the study:

1. *How do teachers perceive the relevance and practicality of the module?*
2. *How do teachers actually use the module and reflect on its major intentions in classroom practice?*
3. *How do students experience learning using the module?*

6.3.2 SAMPLING

This study aimed at investigating how the physics module facilitated teaching and learning as promoted by the SEITT approach. To achieve this objective, a purposefully mixed sample of RTs and non-RTs was selected. The researcher deliberately targeted five RTs who had distinguished themselves during training and in workshops as able teachers. To see how 'average' teachers fared teaching when using such materials, four teachers who were non-RTs and had not yet taught the section covered by the module were identified and invited to participate. Such a sample mix was seen as useful in facilitating identification of problematic aspects of the module caused by poor writing and problems brought about by a lack of sufficient training in pedagogy. The nine teachers in the sample came from nine schools spread over five provinces. Table 6.2 provides some information concerning this sample.

Table 6.2
Characteristics and teaching environments of teachers involved in the evaluation of the physics module (n = 9)

ID	RT status	Teaching experience in years	Class size	Equipment status	Province
A		1	7	++	Harare
B		2	13	–	Harare
C	RT	6	11	+	MASH
D		10	12	–	Harare
E	RT	6	8	–	Harare
F		4	12	+	Mash East
G	RT	4	14	+	MAN
H	RT	5	18	–	MAT
I	RT	6	20	–	MAT

Notes: ++ well equipped; + moderately equipped; – poorly equipped.

The average teaching experience of teachers in the sample was 4.9 years. This compares well with the current national average of seven years. Emigration of experienced teachers accounts for this low figure. The average class size was 12.8. Size of physics classes is generally low compared to the average class size (26) in biology, chemistry, and mathematics in Zimbabwe.

6.3.3 DATA COLLECTION

Four methods of data collection were employed in the study: questionnaires; observations; interviews; and focus group discussion. Table 6.3 relates research questions to data collection methods.

Table 6.3
Data collection methods in relation to research questions

Research question	Questionnaire	Observation	Interview	FGD with students
How do teachers perceive the relevance and practicality of the module?	√			
How do teachers actually use the module and reflect on its major intentions in classroom practice?		√	√	
How do students experience learning using the module?	√	√		√

Notes: FGD = focus group discussion (interviewing students in a group).

QUESTIONNAIRES

Two questionnaires, one for teachers and the other for students, were prepared and administered.

TEACHER QUESTIONNAIRE

To investigate teacher perceptions of the module, a 21-item questionnaire was prepared. The questionnaire sought the teacher's perceptions of issues related to the following: "contextualisation" of content; suitability and availability of materials for practical work; and pedagogical issues. The questionnaire contained eleven closed (yes/no or good/poor) response type questions. This form of simple response was considered suitable since it gave a quick indication of the position of the respondent. Each of these responses was immediately followed with a question requiring an explanation for that position. Put together, this combination of questioning was considered sufficiently informative. The questionnaire also contained ten open-ended questions about the teacher's perceptions of the content in the module, practicality of recommended teaching procedures, and giving reasons on particular answers. A copy of the questionnaire is included in Appendix D2.

The teacher questionnaire, a copy of the teacher's guide, and five copies of the students guide were delivered in person by the researcher about six weeks before

observations were made. The completed questionnaires were collected via postal mail before lesson observations were made. All nine questionnaires were returned at least one week before the observation date.

STUDENT QUESTIONNAIRE

To investigate the experiential curriculum, a 21-item questionnaire was prepared and used to sample student opinions on their experiences with the physics module. A copy of this questionnaire is included in Appendix D3. The questionnaire focussed on "contextualisation" of content; practical activities for students; pedagogical aspects; and syllabus coverage issues. The questionnaire was made up of 14 closed (*yes* and *no*) questions. This form of response was considered suitable for students since it made the form simple to answer. Unlike the teacher's questionnaire, students were not required to justify every answer they gave. Three questions required students to provide reasons for their answers. To specify what student meant in their yes/no questions, three other questions required them to provide detail to clarify their opinion. The final question asked students to make suggestions concerning what they would have wanted included in these materials. The student questionnaire was administered soon after the observation of a lesson in each of the observed schools. All 115 students in observed classes completed the questionnaire.

LESSON OBSERVATIONS

To investigate the operational curriculum, a lesson observation inventory, which was in fact a curriculum profile instrument (see Ottevanger, 2001; van den Akker & Voogt, 1994) was prepared and used. The instrument is included in Appendix D4. The curriculum profile was organised around six areas: lesson prerequisites; orientation to learner-centred teaching; lesson management; lesson conclusion; classroom management; and overall impressions. The six areas were grouped into A, B, to F sections respectively, with each section specifying a number of areas for observation. Each area of observation had on average five statements related to the intended actions of teachers during the lesson. The statements are stated in a way that the designers would like to see happening or not happening. If the behaviour was present, then a check under *yes* was made, or *no*, depending on how the question was phrased. The observer also made notes/remarks against some observations to elaborate on the observation. All nine teachers were observed during an 80-minute period. The researcher did seven of the nine observations alone, with the two in MAT observed together by a fellow researcher. Financial and time constraints prohibited more participation by the fellow researcher.

INTERVIEW

Two interview guides (FGD for students) were prepared in advance: one for students and the other for teachers (see Appendix D5). The 11 items in each of the two guides focused on physics content coverage, "contextualisation" of content, layout of the module, and pedagogical issues.

The observed teacher and between five and six of his/her students were interviewed soon after the lesson. The students for the interview were randomly picked from a class list, ensuring a fair mix between boys and girls. The students were interviewed as a group. The student interview was held in a round table fashion with as many students who wanted to respond to a particular question given a chance to do so. Interviewing students provided the researcher with more varied perspectives of the classroom events and provided students with a chance to explain their impressions (Stake, 1995). As with all the observations, this researcher alone did seven of the nine interviews, with the last two made together with a colleague. Both teacher and student interviews were recorded on tape.

6.3.4 DATA ANALYSIS

QUESTIONNAIRES

All data involving yes/no responses were processed by way of frequencies and by computing percentage responses when numbers were large enough to justify such treatment. For the qualitative data, categories were developed. Responses were then summarised and placed under the relevant category.

OBSERVATIONS

Observation of a lesson was coded in terms of presence or absence of specific teacher behaviour or classroom environment. These were later expressed as frequencies across observations. Notes made along with yes/no checks were summarised and patterns across classes noted. A distinction between teachers who were RTs and those who were not RTs was also made in the notes section. In the two cases where another observer was involved, the two researchers compared their observations immediately after an observation. In events where there were inter-observer differences, the issue was discussed further and remarks compared. This always resulted in one position being adopted. There were, however, few and minor differences in these observations to warrant questioning the reliability of the other seven observations where the researcher was alone. The results of the nine lesson observations were then pooled by way of frequencies and percentages.

INTERVIEWS

In all nine schools, the interview sets (teacher and student) were first transcribed verbatim after which they were summarised and grouped depending on similarity of meaning. From the summaries, a pattern of responses emerged. The verbatim transcriptions were carefully read, and ones that illustrated a specific pattern were marked and quoted in the written report.

6.4 RESULTS

Generally lessons progressed rather slowly, with most teachers failing to complete teaching their lessons within the 80-minute period. This resulted in teachers failing, within the observation period, to cover enough work for students to write a test found at the end of the module. Even if students wrote the tests, it would have been difficult to attribute any change in learning to the module since teachers insisted on giving notes to their students at the end of each lesson, and students continued to read the same materials in their standard textbooks. The following results, therefore, mainly serve to illustrate the potential of such material to change classroom dynamics and climate, and as intended by SEITT, in ways that are associated with teaching and learning with understanding, rather than making claims about immediate improvement in achievement.

6.4.1 PERCEIVED CURRICULUM

The teacher questionnaire sought teacher views on the following aspects of the physics module in advance of the actual classroom use of the material: contextualisation of subject content; practical activities; subject content; and pedagogical issues. All nine of the identified teachers responded to the questionnaire. This section addresses the first of the three research questions, i.e. *how do teachers perceive the relevance and practicality of the physics module?*

CONTEXTUALISATION OF SUBJECT CONTENT

Eight teachers perceived the story as relevant because it 'contextualised' content well and was familiar to their students whilst one teacher perceived the story as 'irrelevant' because teenagers do not go fishing with their grandfathers but with their peers. This same teacher also said the story did not convey any physics concepts. Asked to comment on what their students thought about the contextualisation, eight teachers indicated their students liked the story. Among the reasons for this was that the story introduced waves from a perspective that was not too removed

from student experiences that it illustrated the concept of waves well, got students thinking about waves, and created a general interest among students. The one teacher said students thought the story was childish and below their academic level.

PRACTICAL ACTIVITIES

Eight teachers thought the activities suggested in the student guide were possible to do with their classes, illustrated the intended concepts well, and that the materials recommended for effecting these activities could easily be found. Whilst this was generally true, all teachers made extensive and specific comments on individual activities. For instance, eight teachers appreciated the use of locally available materials since these were within their small budgets for science equipment compared with imported materials they could not afford. Besides the cost, four teachers who had tried out the materials indicated that some of the materials did not quite suit the purpose for which they were being recommended. Particularly mentioned were problems in securing a spring with the correct specifications to enable sufficiently slow and easily counted oscillations.

Of the activities in the module, all nine teachers considered one particular exercise (Activity 2a, see Appendix D6) very difficult to do. A number of parameters (such as period of oscillation, amplitude of oscillations, and measurement of *d*) were considered difficult to measure. The quality of the material (spring) that teachers used as the oscillator contributed to some of these problems. Given all this, the practicality of this particular activity was very low. The same teacher thought the activities were difficult to do.

SUBJECT CONTENT

The module approach to concept treatment was designed to enable desired concepts to emerge, mainly as conclusions to practical activities. All nine teachers confirmed that the module covered syllabus expectations. Seven appreciated the fact that concepts emerged from practical activities whilst the other two teachers said this was the very weakness of the module. To them learning was too bound to the actual doing of activities, a situation that was unrealistic in their contexts. They suggested that the module should include more direct presentation of concepts (so that students can read and understand on their own). This, however, contradicted the general philosophy of the module. In terms of the treatment of concepts through the espoused pedagogical approach, as opposed to textbook approach of presenting the facts, four teachers argued for the textbook approach since,

according to them, it allowed students to read and understand the facts and concepts on their own. Students could therefore read ahead of the lesson. This was not possible with the module as it was. The four teachers also argued that emergence of concepts was only possible provided all activities had been done and student conclusions were correct. This view contradicted five teachers who perceived that the module approach dealt with subject content in a manner that would facilitate student grasp of physics concepts.

PEDAGOGICAL ISSUES

In recognition of the design guidelines as stated in the module, seven out of nine teachers perceived that the module approach involved students more in the teaching and learning process. There was therefore a recognised departure from the traditional didactic mode of lesson delivery. All nine teachers thought the teacher's guide offered useful suggestions that facilitated teaching in the ways as promoted by these materials. Nine teachers also gave the summary impression that the materials were good for teaching purposes. The following reasons were given for this position: the recommended materials were easily available in the environment or could easily be made at the school (7x); science content was contextually relevant (8x); and it involved the student more in the teaching and learning process (7x). The nine teachers were, however, worried that teaching the entire physics curriculum through activities and extensive involvement of students would require too much time. Such time was not permissible in their tight teaching timetables.

Generally, teachers perceived the content of the module to be contextually relevant and practical. Subject content was perceived to be at the right depth as required by the syllabus. Whilst the majority of teachers appreciated the need to involve students in hands-on activities, almost half of them wanted subject content knowledge to be taught in a traditional way. Use of locally available materials as opposed to expensive and mostly imported materials was highly appreciated by most teachers.

6.4.2 OPERATIONAL CURRICULUM

Classroom observations focused on the way teachers used the physics module in the classroom and how the ideas in the module appeared to influence the teaching process. Through interviews, teachers also reflected on their teaching experiences using the module. This section addresses the second research question: *How do teachers actually use the module and reflect on its major intentions in classroom practice?* Observations were carried out in all nine classes.

A preview of the nine lesson plans drawn and used by observed teachers indicated that there was on average a five-minute introduction involving reading and student discussion of the contextualising story, five minutes of whole class question and answer, 55 minutes of small groups of students doing practical activities, and 15 minutes of whole class discussion and conclusions. From the above, teacher drawn lesson plans were consistent with time recommendations in the teacher guide. Observation of these lessons and subsequent teacher interviews led to results as presented in the following four subsections.

CONTEXTUALISATION OF SUBJECT CONTENT

This section will compare the module objective (to teach physics in context) with what actually happened in the observed classes. Table 6.4 provides two distinct observations.

Table 6.4
Observations on the contextualisation of physics content

Item no.	**Expected teaching approach**	**No of classes where this was present** *(n = 9)*
C1	Teacher refers to real life story (Farai's or alternative)	9
D2	Real life application of activities discussed	1

As shown in item C1, all of the observed teachers introduced the lesson through the contextualising story. In 7 out of 9 classes, students were left to discuss the story among themselves for at least three minutes after reading the story. An opportunity for student discussion was not facilitated in the other two classes. In all nine classes teachers conducted a question and answer session that probed student pre-conceptions of wave motion using the context of the story.

In the conclusion of the lesson, teachers were expected to discuss real life applications of concepts learnt during the lesson. Such discussion was only done in 1 out of 9 classes (Item D2). There was therefore no attempt by the other eight teachers to discuss the relationship between activities done in relation to real life experiences. This one teacher happened to be among three others who managed to complete their lesson plans.

When interviewed about their lessons, seven teachers in classrooms where students discussed the story appreciated the interest the story generated among their students. To quote a typical comment of one of these teachers:" … *the story motivated the students*

as I normally have pupils who sleep in class. Today they were awake. Others who don't normally volunteer to participate or answer questions were doing so. Most students had something to say, even if what they said was not always relevant to the topic". The seven teachers were, however, worried about high noise levels. Of these seven, five teachers were satisfied with the way the lesson had progressed after the introduction, although most said the introduction took longer than expected, and hence ate into the body of the lesson. Teachers, however, justified taking that long since the story generated considerable excitement, and students had a lot to talk about. The two teachers who controlled the class soon after students had finished reading the story were generally happy with the progress they made in terms of time. They, however, generally agreed that they may not have satisfied their students' curiosity concerning the contextualising story. All nine teachers agreed that the story was stimulating to their students, as they had more students than usual participating in the question and answer sessions.

PRACTICAL ACTIVITIES

In the promotion of local and easily available materials, teacher planning and facilitation of practical activities was the focus of this aspect of lesson observation. Generally, all teachers followed the practical and exercise sequence as presented in the module. One particular practical activity presented problems to both teachers and students due to a particular component of the apparatus. Besides this exercise, students were able to perform all the activities they attempted with very little help from their teachers. Besides complaining about time requirements for completion of activities, all nine teachers were positive about this aspect of the module. Table 6.5 summarises observations.

Table 6.5
Practical activities and materials

Item no.	**Expected environment and teacher/student behaviour**	**Prevalence of expectation** ***(n = 9)***
A2	Teacher has required apparatus ready	9
B5	Handling of equipment briefly explained	9
C3	Students set up apparatus using instructions in guide	9
C4	Students have difficulty setting up apparatus from instructions in guide	0

According to this data, all the teachers did what was expected of them. Students did not have problems with instructions or apparatus handling. Whilst all nine teachers had scheduled three short practical activities in their lessons, they only managed to complete one of the three activities with the second activity started but not fully

completed by all classes. According to the teachers, failure to complete lessons was caused by the need to provide students with time to complete each of the activities, not because of any problems with manipulation of apparatus. However, observation also indicated that students were slow in manipulating apparatus.

In none of the nine classes did students encounter difficulty in following practical instructions and doing most of the activities. Students in all nine classes had problems with collection of requisite data for activity *2a*, because the spring used in this activity vibrated too fast making counting of oscillations difficult. All teachers failed to find the spring with characteristics as described in the teacher's guide in their hardware stores (considering that observations were done in five different provinces, this was obviously a major problem). Although all nine teachers appreciated alternative, cheaper, and easily available apparatus, one teacher who came from a well-equipped school suggested the module also present some standard experiments using standard equipment. That way he would not have to flip flop between the module and the standard practical handbook.

SUBJECT CONTENT

As recommended in the module all teachers generally handled subject content in a similar way. In the majority of classes, students had problems drawing good conclusions, and hence concepts did not emerge from practical activities as expected. Teacher mediation in this respect appeared necessary, but was not being done.

Table 6.6
Observations on the handling of subject content

Item no.	Handling of subject content	Prevalence of expectation *(n = 9)*
C11	Students draw conclusions to activities	9
C12	Conclusions are presented to class and discussed	9
C13	Conclusions produce expected concepts	4
D2	Real life applications of activities discussed	1
D3	Teacher gives notes that cover lesson concepts	7

C11 and C12 show that expected class procedure was followed. C13, however, shows that conclusions, though made, were not as expected even though the data collected were good. During interviews, all nine teachers pointed out that their students had problems drawing conclusions. This was mostly attributed to lack of practice in this skill during their earlier years in secondary school where very little practical work was done. Teachers also linked this inability of students to draw

conclusions with their perceived need to provide notes (D3) since, as they reasoned, all students have to leave the lesson with correct concepts they can use for revision later in the year. These results did not show any pattern of differences in implementation between RTs and non-RTs.

When observation D2 was followed up during interviews, 8 out of 9 teachers thought the contextualising story was sufficient. Only the one teacher indicated in Table 6.6 thought introducing other contexts in explaining wave phenomena was essential for student understanding, arguing that relating concepts to real life situations helped students be more aware of their environment and be able to explain it. The teacher also argued that not all students would find the fishing story particularly exciting or relevant; therefore, referring to other life situations helped capture the imagination of more students.

PEDAGOGICAL ISSUES

Investigations of learner-centred orientation to teaching as well as such essentials of a lesson as timing were made. Table 6.7 provides the specific observations.

Table 6.7
Observations on the instructional process

Item no.	**Teacher/student behaviour**	**Yes** *(n = 9)*
B1	Students seated in groups/ organised into workgroups	9
B2	Students have copies of student guide	9
B3	Students engaged in discussion within the first five minutes	3
B4	Lesson objectives are outlined by the teacher	8
C3	Students set up apparatus using instructions in guide	9
C5	Teacher encourages all students to participate in apparatus manipulation	6
C7	Teacher asks questions that relate activity to theory	4
C8	Students encouraged to co-operate to solve problems	9
C9	Students provided sufficient time to work through activity	9
C10	Teacher paces lesson ensuring smooth progression	4
E1	Teacher completes work on lesson plan	3
D3	Teacher does not give notes	2

As advised in the module, all nine teachers grouped their students to facilitate student discussions and co-operation to solve problems, made sure all students had a copy of the module, outlined lesson objectives (8x), and ensured students used module instructions to set up and perform practical activities. The table also shows four areas where less than half of the teachers did not perform according to expectation. These areas are the following: engaging students within the first five

minutes of the lesson (B3), which points to teachers talking a lot; failing to engage students in relating activities to physics concepts (C7); failing to complete work on lesson plan (E1); and providing notes in situations where students could have written their own (D3). When teachers talk a lot, the consequence is failure to complete work on the lesson plan. Such a failure makes it difficult for conclusions to be made since students need time to analyse and discuss their results, draw conclusions, and then further discuss the same as a class. Failure to provide such time would make implementation of such a curriculum less meaningful. Failure to complete lessons fuels note-giving practice "to provide students with expected learning". These results also did not show any pattern of differences in implementation between RTs and non-RTs.

In the post-lesson interviews, teachers discussed what they found good about the lesson format and also reflected on their lessons. All teachers appreciated the provision of lesson objectives in the module since this made it easier to pass them on to students. Also recognised as useful were suggestions on what to do during the time students were doing practical activities. The four teachers who did not prompt students to link practice with theory conceded that they were aware of the need to do so but preferred that students learn the concepts through drawing relevant conclusions. There was a greater chance of learning that way, they argued, than otherwise. As discussed in subject content, teachers acknowledged that students have problems with drawing conclusions. They justified extensive note giving from this perspective. This practice, however, deviates from the expectation of the curriculum designers that students learn to draw good and reliable conclusions from which they learn science concepts.

The six teachers who failed to complete the lesson plan attributed this to the need to allow students to discuss issues and complete practical activities. If this situation was maintained in every lesson, it would be, the teachers suggested, impossible to complete the syllabus. One of the six teachers was, however, optimistic that with practice in the use of this teaching strategy, both he and his students would likely find ways of speeding up the process. When it was pointed out that the time for giving and taking down notes could have contributed to the problem, all six teachers who engaged in this practice defended the practice as essential. Notes were meant to provide a structure to link concepts to facilitate revision. These teachers did not think that conclusions arrived at during discussions or practical work constituted sufficient material to facilitate later revision and did not think that their students were capable of using the objectives as a guide to ensure lesson essentials had been grasped.

All nine teachers agreed, however, that their students were livelier during the lessons where the module was used. Teachers also acknowledged that students displayed a better understanding of concepts. This is illustrated best by the following quotation from one teacher: *'yes there was a difference. When I taught this topic it was (before) always me doing the talking, telling them everything. Their participation in this lesson was much more than in the previous lessons. The module departs from the usual (traditional method) way'.* In terms of bringing about understanding, another teacher said, *'The students understood better. They participated more instead of just listening and writing. They answered the questions given and worked out the exercises so that when the teacher comes with the actual answers, they were eager to compare them to theirs. By doing it themselves, they understood better'.*

On the whole, contextualisation was used but tended to be limited to lesson introduction while the intention of the module was to let this carry throughout the lesson. Teachers were able to supply most of the materials as expected whilst students found most of the materials easy to handle and instructions in the module comprehensive enough to facilitate doing the activities. Although students did the activities as expected and recorded good data, they had problems drawing relevant conclusions. Teachers reacted to such failures by providing comprehensive notes. Those notes were already in their notebooks and were simply transcribed onto the chalkboard for students to copy. Note giving was therefore part of the teacher's lesson plan rather than an attempt to rescue the situation. Teachers saw note giving as a way to ensure students 'had the correct concepts', something they didn't seem to believe could be achieved through the drawing of good conclusions. Given the above, teachers were not committed to the strategy.

6.4.3 EXPERIENTIAL CURRICULUM

Data from student questionnaires (n = 115) and post lesson group interviews (n = 54) was used to extract information to address the third research question, i.e. *How do students experience learning using the module?* Those data are grouped into four themes, as presented below.

CONTEXTUALISATION OF SUBJECT CONTENT

Ninety percent of students enjoyed reading the contextualisation story with 79% saying the story was a good introduction since it got them to think about waves. They reported (and were observed) discussing a lot among themselves as a result of the story and had a lot to talk about with their teacher during the lengthy question and answer opening of observed lessons. The following phrases captured student

reactions to the story: '*you could picture the whole situation; it provided something solid to make reference to during discussions; although I've never fished before, it was a familiar story; and, I understood better due to continued reference to the story'.*

PRACTICAL ACTIVITIES

With respect to practical activities, 100% of students found instructions easy to follow. This was attributed to the simplicity of language used in the module. The same percentage of students said the materials were easy to handle and manipulate. Whilst 100% of students found activity one easy to do and its apparatus easy to manipulate, 68% of students found activity *2a* (see Appendix D6) difficult. This was attributed to one particular piece of apparatus that made taking measurements difficult, a point that was also mentioned by their teachers.

SUBJECT CONTENT

For student clarity, subject content had been approached from the perspective of comparison between module and standard textbooks. Here students were asked to evaluate the clarity of conceptual presentation between the module and their conventional standard textbook. Fifty three percent of students liked the way the module presented content. During interviews, they said this was because the module was very clear in terms of writing style and the level of English used. Fifty one percent of students preferred to use a combination of textbook and physics module. Students viewed textbooks as having all the requisite physics concepts whilst student guides had all the essential hands-on exercises. To students, the two were complementary. Furthermore, none of the students thought use of the textbook alone in the teaching of concepts was adequate. They further added that they both approached concepts from different perspectives thus aiding understanding. To improve the student guide, 70% of the students suggested the authors include more direct concept presentation and explanations. Thirteen percent suggested inclusion of multiple choice practice questions in exercises so that the format of the questions in the guide conform to A-level examining techniques.

PEDAGOGICAL ISSUES

As opposed to the traditional practice where practical activities were performed purely for skills development whilst teachers made direct presentation of physics concepts through chalk and talk, the module fused the two and used practical activities to derive physics concepts. This was the focus of the research in this area. Ninety one percent of students preferred the new approach. During interviews, 75%

of students concurred with this position, citing the liberty to participate fully in lessons through doing, and discussions with their teacher and their classmates as the major reason for saying so. One student expressed this preference this way: *'Today we were interacting and asking friends. If one did not understand it was explained. Some even got to understand it* (the concepts) *today'*. Another student said, '*it makes my understanding to be much better because you find that practical situation brings about insight into what we are doing in class. It's not just all theoretical. It can also be applied in real life.'* Forty-three percent of students, however, suggested it was also important that they work as individuals since examinations require that they do practical activities as individuals. Working as a group does not provide them with sufficient practice for examination purposes. Student responses did not show any distinct differences between those taught by non-RTs and those taught by RTs.

On the whole, data revealed that students liked the new teaching approach because they felt they were now more involved in the lesson than before, attributing increased understanding to this fact. They, however, had reservations about continuing to be taught that way, citing lack of explicitness in concept presentation in the text of the module. This made it difficult for them to continue their usual practice of reading ahead of the lesson. According to students, this was the major problem with the module approach, hence their preference to use the module in combination with standard textbooks. They further thought that working in groups did not prepare them well for examinations since examinations emphasised individual work.

6.5 CONCLUSIONS

6.5.1 PERCEIVED CURRICULUM

In responding to the question, *How do teachers perceive the relevance and practicality of the physics module?* conclusions can be drawn with respect to the four areas: contextualisation; practical activities; subject content; and pedagogical issues. The results lead to the general conclusion that the physics module was perceived to be relevant and practical, as intended. The pedagogical approach used in the module was on one hand perceived as increasing student participation in lessons and at the same time posing challenges related to syllabus completion. The following, more specific, conclusions are drawn.

- Contextualisation of subject content was viewed as beneficial to both teaching and learning. For teaching, it became a launch pad for the introduction of concepts whilst providing motivation and a concrete example for supporting

student learning. Contextualisation, however, had to be socially and academically relevant. Since students came from different backgrounds, there was also a need for flexibility, thus allowing teachers to use contextualising scenarios appropriate for their students.

- Practical activities were perceived as constituting a good basis for intended concept development. Developers, however, needed to revisit some of the apparatus to ensure all recommended apparatus worked as expected.
- The emergence of concepts from practical activities was too tied to the actual performing of those activities, a situation that was considered not always tenable in local environments. Teachers valued previous practices where students could read ahead of lectures, a practice that was no longer possible in the recommended pedagogical style. This was likely to pose problems in the use of the module.
- The fundamental aim of actively involving students in teaching and learning had been well received by teachers, notwithstanding the general concern that such involvement had a tendency, as observed in the few lessons done, of slowing down the teaching and learning process, thereby leading to problems with syllabus completion.

6.5.2 OPERATIONAL CURRICULUM

Classroom practices of teachers were investigated through the question: *How do teachers actually use the module and reflect on its major intentions in classroom practice?* Results lead to the general conclusion that teachers used the module as expected, but had lesson timing problems, leading most teachers to fail in completing their lessons. Teacher reflections also suggest that module aims were achieved. Due to student lack of skills in drawing conclusions and the teachers' failure to assist, it would be difficult to achieve the aim of yielding physics concepts from practical activities. This would imply that students were provided with more guidance during practical activities, either through the teacher or directly through the student guide. Such guidance was observed particularly necessary at the point of drawing conclusions. That way, student deliberations among themselves would lead to correct conclusions thereafter confirmed through whole class discussions. Once done, this was likely to give students more confidence in their own notes, reduce the need for teachers to give standard notes, and at the same time create more lesson time for teachers to complete their lesson plans. With respect to the four areas under which results were presented, the following more specific conclusions are drawn.

- Contextualisation of subject content motivated students to participate in the lesson and raise the level of curiosity among students. Where teachers lengthened discussions to exhaust such curiosity, introductions became lengthened. This resulted in uncompleted lessons, and where introductions were cut short, students' curiosity was not satisfied.
- Substitution of imported equipment with locally available and cheaper materials was well received by teachers, and this appeared to facilitate practical work. Authors, however, had to ensure substitute materials were locally available.
- Teachers had timing problems that resulted in failure to complete work in their lessons plans. This was mostly caused by their failure to judge the amount of time students needed to complete a particular exercise.
- Generally, students valued the hands-on approach. However, their failure to draw conclusions made learning through this method rather difficult. Although more solid conclusions were arrived at during student teacher discussions, teachers cited this fact as their reason for providing students with notes. As such, the recommended pedagogical style did not work as expected.
- Teachers were able to perform the technical aspects of the lesson such as grouping students, ensuring each student had a module, and adhering to module instructions for practical work. The important aspects of the lesson such as completion of lesson plan, relation of activities to physics concepts, and getting students to write their own lesson notes presented problems for most teachers. Given the above, whilst expected lesson concepts were adequately covered, they did not emerge directly from student conclusions in most cases but through notes that presented the concepts from teachers. Teachers, therefore, tried to do as expected but also combined expectation with their old note giving practice. It appears that the practice of giving notes to students was deeply rooted in teacher practice.

6.5.3 EXPERIENTIAL CURRICULUM

Generally, students found the activity-based and highly interactive approach to learning exciting and conducive to a perceived increase in understanding. Students, however, were not convinced that such activity-based learning could yield concepts equivalent to those in their textbooks, and hence the insistence that their textbook and the module were complementary. Student caution was reinforced by the teacher practice of note giving, which also suggested that teachers were not convinced such teaching and learning could be complete in itself. More specific to the four areas specified in the results, the following conclusions are made.

- Putting physics in context positively influenced student attitude towards the topic and resulted in increased co-operation among students. The claim by students that it increased understanding, the very reason for employing this methodology, would need further and more in-depth studies on the effectiveness of the module.
- Besides the one activity that students and their teachers found problematic, practical activities were comprehensible and easier to carry out compared to those in standard laboratory manuals. The simplicity of language used contributed to making instructions easier to follow.
- Whilst students rated review exercises as good, the 50-50 split between students who preferred the module approach alone and those that cited complementarity of the module and textbook approach implies that many students did not 'see' the concepts in the practical activities as intended. To students, it would appear expedient that concepts were directly presented in a traditional teacher-centred lecture strategy for the purpose of completing the syllabus for examination purposes. This need, in the short term, appeared more important to them than the understanding brought about by interesting ways of learning—learning that was, however, too time consuming.
- Students enjoyed being taught through activities and co-operative group approaches to the extent that they claimed to have understood better. The substantial number of students who recognised the importance of working as individuals, and who cited the need to practice for examinations, shows that whilst students welcome new teaching approaches, the dissonance between these practices and examining practice poses problems.

6.5.4 OVERALL CONCLUSION

The findings of this study, therefore, reveal that whilst teachers appreciate the physics module, and students enjoy the freedom to learn through cooperation and learning by doing, especially by the introduction of locally available substitute teaching materials, and the accompanying pedagogical style, there was a conflict between the advocated teaching approach and what teachers believed was best to enable their students to pass A-level external examinations. The focus of teachers and students was on timely completion of the syllabus and getting students to pass the A-level examination. Although there were time problems, both RTs and non-RTs were rather successful in implementing the intended change in classroom practice. The inclusion of procedural specifications in the materials contributed considerably to this overall success. The study also shows that both sets of teachers had similar implementation concerns. This shows the module had the potential to bring about

the desired change in classroom dynamics. The results also communicate to the physics module authors that some issues still need to be revisited in order to improve the module and that those issues hindering implementation of such a promising teaching and learning strategy need to be pointed out.

The outcome of this study did not show any difference in teaching using the module between the RTs that were part of this study and those teachers that were not RTs. The provision of procedural specifications in the teacher's guide accounted for this outcome, showing that procedural specifications (van den Akker, 1988, 1994) brought the less prepared teachers to the same level as RTs. This lack of difference between RTs and non-RTs also demonstrates that when it comes to facing realities of the system (concerns about syllabus completion and examinations), RT concerns were the same as other teachers. On the whole, the outcome of the COLECT study goes to show the potential of including curriculum materials in the SEITT approach.

- 7 -

DISCUSSION

In this chapter the results of the RT study are discussed, overall conclusions drawn, and recommendations are made. Section 7.1 recapitulates the research problem and approach. The following section, 7.2, summarises the findings of this study. These findings are discussed in section 7.3. Section 7.4 reflects on the design of the study. The final conclusions of the study are presented in section 7.5. The chapter closes with section 7.6 where recommendations are made.

7.1 RECAPITULATION OF THE RESEARCH PROBLEM AND APPROACH

Since 1980 Zimbabwe has experienced problems with the provision of quality teaching and learning in secondary school science education. To mitigate this problem, the Science Education In-service Teacher Training (SEITT) project was initiated in 1994. After doing a needs analysis, SEITT identified a number of factors resulting in a lack of quality teaching and learning. The most prominent among them were: low competency in subject content knowledge by some teachers; low competency in appropriate pedagogy by most teachers and, insufficient teaching materials in most schools due to poor budgetary allocations to schools. Zimbabwean students also had to use imported textbooks written for students whose first language is English, whereas for most of them, English is a second language. In view of these factors, SEITT set out to ameliorate the overall problem through a cocktail of strategies as defined by the SEITT approach (section 2.4). This approach is structured around the conception that teachers are the most appropriate people to in-service other teachers (Dadds, 1997; Fullan, 2001; Jones & Baker, 2005; Loucks-Horsley et al., 1998). SEITT identified a group of teachers and offered them formal education and training so that they became resource teachers (RTs). These RTs were then used to in-service their peers through a comprehensive professional development programme implemented at the provincial level.

The main focus of this study was to evaluate the SEITT strategy in preparing and supporting RTs for their facilitative roles as they implemented the SEITT approach. This study included four stages.

- The first stage constituted a reconstruction of the SEITT approach. The purpose of this stage was to enquire and assess the SEITT approach itself in light of international literature on professional development. The reconstruction study was implemented through a literature and document review.
- The second stage involved the investigation of RT pre-implementation perceptions concerning their training and roles as well as the perceptions of other stakeholders concerning the training and roles of RTs. The perceptions of RTs and stakeholders appeared relevant, as they were likely to affect how RTs implemented their roles within the SEITT approach, as well as determined the amount of support RTs needed. All graduate RTs at the time were surveyed by questionnaire whilst all Education Officers (EOs) of science and mathematics in the sampled provinces and two school heads in each of these provinces were interviewed.
- The third stage evaluated the way RTs implemented their roles within the entire SEITT approach, and how they were facilitated throughout this process. This main study used a longitudinal case study approach. Data were collected over a three-year period, from the same RTs, EOs, school heads, and teachers where possible. The three out of nine case provinces were selected because they were most active and hence the most informative. This sample as a whole had more schools in rural areas than in urban areas. Within each of these three cases, the most active RTs were chosen since they were likely to yield the most data. These most positive contexts and information sources were meant to yield maximum information, thereby optimising our learning about the implementation of the SEITT approach. All relevant EOs and the provincial directors of education in the three cases were also included in the sample. Data were gathered mainly through interviews, observation, and questionnaires.
- The SEITT approach emphasised on curriculum materials to act as a bridge between PCK workshops and classroom implementation. The curriculum materials carried what teachers learnt at PCK workshops and were intended to help teachers operationalise these ideas. This fourth and final stage (COLECT study), therefore, investigated how a physics module that was written within the SEITT approach facilitated this intended teaching and learning. In this study, five out of nine sampled classrooms were taught by RTs, thus presenting an opportunity to assess how RTs implemented constructivist ideas in live classrooms. Also participating were four other non-RT teachers spread over five

provinces. For the overall question, teaching by RTs provided data concerning how well they could translate their education and training into classroom practice themselves. For the non-RT teachers, teaching performance indirectly reflected the effectiveness of PCK workshops and material procedural specifications. Data were collected over a two-month period via questionnaires, lesson observations, and student and teacher interviews.

As a whole, the study focused on investigating the potential of the RT strategy in implementing a programme such as SEITT approach rather than offering comprehensive evaluation of the SEITT approach. The study as a whole aimed at answering the research question: *How successful was the SEITT strategy in preparing and supporting resource teachers for their facilitative role?*

7.2 SUMMARY OF MAIN FINDINGS

In this section, a summary of the findings of the evaluation study is presented. This is done in the order in which the studies were carried out and presented in this book.

7.2.1 RECONSTRUCTING THE SEITT APPROACH

The SEITT approach constituted a plan to provide professional development for Zimbabwe's A-level teachers of science and mathematics, with an overall goal of helping these teachers aim for teaching with understanding. This reconstruction study sought to answer the following question: *Was the SEITT approach likely to yield its goals when viewed from international literature on effective professional development?*

To respond to this question, the reconstruction study first focused on the fundamentals of professional development. This involved a literature review on learners and learning, teachers and teaching, and the nature of subject content knowledge, since, on the whole, this project aimed at influencing classroom practice. Armed with this knowledge, the reconstruction then focused on the elements of the SEITT approach (*developing professional developers, science and mathematics centres, PCK workshops, curriculum material writing, networks, technical support,* and *research*). The literature review asked whether these components addressed, with teachers, the issues relevant to teaching with understanding. Thereafter, a discussion of each element focused on its efficacy and whether each of these components was consistent with the principles of effective professional development.

The reconstruction came to the conclusion that the SEITT approach was built from a recognisable knowledge base about teaching, learning, and professional development. It incorporated practices that reflected principles of effective professional development. This finding, however, only confirms that each element has its own potential in professional development. The reconstruction as a whole does not shed much light on the potential of the combination of these strategies in the SEITT approach to address the challenge of realising teaching and learning with understanding at a large scale. Whilst the combination presents a comprehensive plan, the linkages between the elements make this multimode plan vulnerable since weakness in one element will weaken the whole chain. The efficacy of these combined strategies in the SEITT approach was still dependent on proper implementation. It was also noted that the literature base used in the reconstruction derived mostly from activities carried out in developed world environments, whilst similar work in developing countries faced implementation challenges. A further comparison with the principles of professional development indicated that whilst the plan reflected most of the principles, one very important principle requiring systemic professional development had not been considered. This principle addresses the systemic issue to link the proposed teaching approach to curriculum and examination procedures and techniques. Failure to address these two components of the education system might place the whole plan in jeopardy as far as implementation of constructivist teaching and learning is concerned.

7.2.2 RT AND STAKEHOLDER PERCEPTIONS OF RT ROLES AND SMC FUNCTIONS

This study investigated the perceptions of RTs with respect to the adequacy of preparation for their roles. The perceptions of school heads and education officers were also investigated with respect to RT roles and SMC functions. The study sought to answer the following research questions:

1. *How well did RTs feel the diploma programme had prepared them for specific roles within the SEITT approach?*
2. *What were RT perceptions of their roles compared with those of the SEITT approach?*
3. *What were stakeholder perceptions of RT roles and the function of SMCs, respectively, compared with those of the SEITT approach?*

Findings indicated that RTs viewed their training through the diploma program as adequate with respect to PCK workshops, SMC management, co-ordinating teacher networks, and research. They perceived that they were inadequately trained in CMW. RTs perceived learning their roles mostly from those course aspects combining

theory and practice. With respect to role perceptions, RTs identified strongly with the role of PCK workshop planner and implementer, and researcher, but weakly with SMC manager and co-ordinator of teacher networks. Consistent with their perception of inadequate preparation for CMW, this role was mostly left out. Compared with stakeholder perceptions, both perceived RT roles mainly as running PCK workshops and managing SMCs. Stakeholders were not aware of the other roles of RTs as prescribed by SEITT but added the role of resource librarian consistent with their view of SMCs as resource libraries as well. Otherwise, stakeholders displayed a good knowledge of SMC functions.

In discussing the outcomes of this study, it was predicted that RTs were likely to implement those activities that matched their perceived roles whilst ignoring those that did not. At the same time, they would not meaningfully implement such activities as CMW for which they felt they had been inadequately trained and which they, therefore, deemed not important. Implementation of the PCK workshop and SMC management roles was likely to be prominent since both RT and stakeholder perceptions converged on these two roles.

7.2.3 EVALUATING RT PRACTICE

This study evaluated how RTs in the three case provinces implemented the two preconditions of SEITT (*action plans* and *fundraising*) and the five action points of SEITT *(PCK workshops, CMW, networking, research,* and *SMC management)* over a three-year period. RT implementation was compared against SEITT expectations for each of these seven implementation areas.

ANNUAL ACTION PLANS

This part of the study was guided by the following research sub-question: *What was the quality of action plans drawn by each of the three provinces?*

The quality of the action plans was judged according to whether they included the five action points of SEITT, the frequency of planned activities against expectations, the sufficiency of detail to make the implementation of such plans transparent, and their sensitivity to continuity, a condition that facilitates change.

Compared to SEITT expectations, the following observations were made. None of the plans included the five action points of SEITT in each year of implementation. Plans consistently failed to include networking and research but were observed to add activities outside those recommended by SEITT, activities that differed between

the cases. Such activities were considered important by the provinces that added them. The frequency of planned activities was consistently lower than expected in all three plans over the three years. RTs considered the six workshops per year (two per term) requirement unrealistic due to time constraints. Generally, plans lacked sufficient detail to make proposed implementation procedures transparent. RTs argued that implementation detail was added at the time that the activity was due for implementation. Sensitivity to continuity was very low in all three cases over the entire three years, most notable being the failure to organise follow-up activities.
The evaluation concluded that action plans were fragmented and fell short in meeting the criteria of SEITT in all respects.

FUNDRAISING

This part of the study was guided by the following research sub-question: *How successful were provinces in fundraising?*
Success was judged by the ability to raise a minimum of Zim$48,000, an amount at the time that could finance at least six workshops per year. It was also judged by the ability to source funds from permanent and sustainable sources.

Results indicate that, on average, two out of three cases succeeded in meeting the first criteria. Furthermore, the amounts raised varied among the provinces and from year-to-year. Such variation does not help implementation since, for instance if no money is raised in the first year, that implementation slot is lost for good. Due to RT teaching loads, each implementation year can only accommodate a limited number of activities. Funds were also raised, not only for workshops, but for all other activities of SEITT in the provinces, including management of the SMC. With respect to the second criterion, all cases had appealed to their respective SDAs/SDCs, a source that SEITT considered sustainable.
The evaluation concluded that fundraising was successful in two out of the three cases, but it netted only average amounts.

PCK WORKSHOPS

This part of the study was guided by the following research sub-question: *How was the PCK workshop component of the SEITT approach implemented?*
The level of success was judged against a set of five criteria on the following key components: set up at least four PCK workshops in first two terms of each year, provide opportunities for teachers to learn PCK, stimulate sharing of teaching ideas among teachers, generate material for CMW, and involve subject experts from tertiary institutions and industry as resource persons.

Results indicate that provinces implemented, on average, two PCK workshops per year. This was consistent with their action plans but was not what SEITT intended. The two workshops per year concentrated on subject content in new areas of the syllabus with teachers sharing about how best to teach this subject content. As such, opportunities for teachers to learn PCK were provided. In these workshops, interactions among teachers and with RT provided teachers with opportunities to articulate and discuss their personal experiences. Such sharing was consistent with the third criterion. In the process of such sharing, teachers proffered innovative ideas for teaching subject content that could have constituted a basis for CMW. Results also revealed, contrary to SEITT intentions, that RTs and teachers preferred to draw resource persons from their own body instead of bringing specialists in from outside. They strongly believed there was sufficient knowledge and skills among themselves to professionally develop each other.

This part of the study concluded that RTs implemented workshops according to their action plans but not according to SEITT intentions. Given this, they implemented two workshops per year as opposed to the four expected. These workshops were based on new areas in the syllabus that teachers found difficult to teach, used sharing among teachers as the *modus operandi*, and thus generated material for CMW although such writing was not being initiated. Whilst SEITT expected teachers to learn from outside experts, RTs and teachers did not see this as a priority, preferring to learn from each other first.

CURRICULUM MATERIAL WRITING (CMW)

Evaluation of this aspect was guided by the following research sub-question: *How was the curriculum materials writing component of the SEITT approach implemented?*

The level of success was judged against two criteria: the association of a CMW with a PCK workshop and the establishment of writers groups as a post PCK workshop activity to write curriculum materials based on the outcomes of that workshop.

Findings indicate that CMW workshops were few and far between and generally independent from PCK workshops, contrary to SEITT intentions that each PCK workshop would generate content for CMW activities. Where attempts at CMW were made, the process combined the content of more than one PCK workshop and took too long and eventually appeared to collapse at some point along the process. Generally, CMW did not take place because RTs concentrated on PCK planning and implementation and appear to have ignored CMW. What RTs did all the time was issue forth their workshop notes. Teachers combined these notes and their own for

classroom implementation of PCK workshop ideas. On their own, these documents were insufficient since the intention of SEITT was for CMW to capture and express the consensus of teachers and RTs in PCK workshops. Therefore, SEITT criteria in this respect were not met. Some other organised and collective types of writing, however, took place. In one province, the writing of examination papers and their subsequent use was successful, although it was achieved by only one of the four SEITT subjects. RTs attributed the failure of CMW to a number of problems including the lack of time to do writing or discuss writing with teachers as a post PCK workshop activity. When writing was initiated, teachers making trial drafts took too long to provide feedback. RTs also mentioned their lack of confidence in the writing and supervision of the writing process.

This part of the study came to the conclusion that RTs had abandoned the SEITT intention to link PCK workshops with materials writing, preferring, whenever they wrote, to combine the content of previous PCK workshops in one CMW activity. Over the three-year period, RTs had also replaced CMW with their own pre-workshop notes, supplemented by notes made by teachers, to effect workshop ideas at classroom level. Time as well as lack of expertise in writing accounted for the failure of CMW.

NETWORKING

Research on this aspect was guided by the research sub-question: *How was the networking component of the SEITT approach implemented?*

Three criteria–regular subject group meetings, production of SEITT magazine and provincial newsletters, and communication among teachers via e-mail and the Internet–were used to evaluate this aspect. This aspect also sought to establish problems that RTs encountered during implementation.

Findings indicate that planned networking via magazines, subject associations, and computers failed throughout the three years. Production of magazines (with only one produced in the first year by SEITT and one newsletter produced by one province) failed due to a supposed lack of interest in writing by teachers. The revival of subject associations failed due to the continued emigration of science and mathematics association leaders. Failure of electronic networking was due to poor infrastructure, the inaccessibility of computers since the SMCs turned out to be inaccessible to the majority of teachers and RTs, limited RT and teacher skills in the use of computers, and the problems of meeting telephone bills for each centre. The problem of poor infrastructure was not foreseen since SEITT considered the availability of direct telephone lines as the only condition necessary to make the

Internet work. Although direct lines were in place on the ground, in some cases they were shared with other offices and were therefore often busy when RTs and teachers needed to use them. The problem of the lack of computer skills was originally considered surmountable since teachers could be trained within a short time. Computer training workshops, however, suffered the same fate as most of the other activities, due to time problems. Despite all this, results show that the PCK workshop platform served the networking function, but with only limited effect due to the frequency of these workshops.

The failure of this aspect of SEITT led to the conclusion that RTs were not sufficiently equipped and facilitated to run this component, and at the same time, especially with electronic networks, that the environment was generally unconducive to the implementation of teacher networks throughout the three years.

RESEARCH

This part was guided by the research sub-question: *How was research, as a component of SEITT, implemented?*

Need analysis research, workshop evaluation and classroom research constituted the criteria for judging RT implementation of this component.

Results show that RTs did workshop evaluations for every workshop they implemented throughout the three years but that they only analysed the results in part. Need analysis research was done in two out of the three years in all three provinces. RTs did not see the necessity of doing needs analysis in the third year since they had not exhausted the teacher needs of the previous two years. RTs did not initiate classroom research, arguing that such research was supposed to be in collaboration with their university partners. They had expected these partners to initiate this research. This had not happened.

DEVELOPMENT AND USE OF SMCS

As with other elements of the SEITT approach, RTs were expected to manage SMCs, and working together with their EOs, develop these centres beyond the basic structures funded by SEITT. This part of the study was guided by the research sub-question: *How were SMCs, as a component of the SEITT approach, implemented?*

The following five criteria were used to evaluate SMC development and use: a venue for workshops; a source for reference materials; a communication centre; a meeting place for teachers; a centre for stocking and distribution of curriculum materials written within the project; and development of SMC beyond what SEITT provided.

Results of the SMC concept implementation indicate that throughout the three years, RTs used SMCs as a base for the development and running of all the workshops they implemented. SMCs were primarily designed and equipped to facilitate this function. RTs, and to a limited extent teachers, also accessed SMC reference books for their own teaching. All provincial meetings of the management committees were held at the SMCs. For the majority of teachers, however, SMCs were inaccessible as meeting places due to distance, especially for the majority of teachers in rural schools. In the worst case, these schools could sometimes be located as far as 200 kilometres away. Only one centre, MAT, succeeded in operating as a meeting and communication centre, but only after the centre had relocated from its original school location into the city centre. This happened in the third year of data gathering. None of the three provinces met the last criterion because no materials had been developed. Only one SMC, MAT, managed to develop beyond the basic inventory that was provided by SEITT. This SMC managed to increase its resource textbook base by more than 100%, added four more computers to the basic inventory, and utilized these computers to run an Internet café for the province's teachers. RTs in this province took turns managing the SMC every afternoon, five days a week, with their SMC paying them an allowance for commuting fares. SMC development, especially as a communication centre for the other two provinces, was negatively affected by the lack of good telephone lines to make the IT component work, and the financial constraints of heavy telephone bills. Given all this, even when it was working, the IT facility was hardly accessible to the majority of teachers in their respective provinces.

In evaluation of this section, SMCs were, over the three years, successful as places for the preparation and hosting of workshops, and partly successful as sources of reference materials, meeting places, and communication centres. SMCs were generally inaccessible to the majority of teachers due to their distance from the centre whilst problems with IT connectivity made SMCs generally dysfunctional as communication centres. Only one centre developed its SMC well beyond what SEITT had sponsored.

FACTORS THAT INFLUENCED RT IMPLEMENTATION OF THE SEITT APPROACH

RT implementation of the SEITT approach was not only influenced by their education and training but by their operational environment as well. This part of the study reports on these factors. It was guided by the research sub-question: *In what ways did the environment of RTs influence their implementation of the SEITT approach?*

The following were the factors that positively influenced implementation.

- *Partnership with EOs*. Participation of EOs in the implementation process was at the collegial, rather than the superior-subordinate level. EOs and RTs shared the platform when communicating with all teachers and school heads, thus indicating an implementation partnership. This relationship facilitated recognition of RTs by teachers, school heads and parent bodies and improved the image of RTs within the general education community.
- *Pressure and support*. At the national level, key stakeholders such as provincial directors and university co-ordinators often shared the platform with RTs in addressing teachers and school heads, whilst at the provincial level, EOs, RTs, the SMC host school head, and representative head of all school heads in the province were members of the MC. In MASH, one of the four RTs chaired the MC. Formal education of RTs could account for such support since stakeholders viewed RTs as academically qualified for the roles they played in SEITT. This is in line with literature that says change agents must be well educated to implement such programmes (Fullan, 2001; Miles, Saxl & Lieberman, 1988). The literature considers such support to be necessary to facilitate change (Oakes et al., 1998; Fullan, 2001; Jones & Baker, 2005). Also the presence of this mix of stakeholders exerted implementation pressure and support for RTs. Pressure, however, could have only succeeded if such stakeholders had full knowledge of what RTs were expected to do.
- *Addressing the real needs of teachers*. Teachers had real or perceived needs that RTs addressed upon request. Although such needs sometimes caused RTs to digress from activities mutually agreed upon with SEITT, such digression helped teachers and thus increased teacher support for this RT driven programme.

The following factors negatively influenced implementation.

- *Lack of time*. RTs cited time constraints as part of the reason for the failure to implement more activities than they were able to. Roles such as managing SMCs and CMW were adversely affected. Overloaded teaching timetables mostly caused this.
- *Missing incentives*. The two-year delay by MoESC in implementing the additional salary notch for all qualified RTs and in creating a remunerated post of special responsibility for those RTs serving SMC managers, demoralised RTs.
- *Lack of financial compensation*. On the whole, RTs were not financially compensated for executing their duties. Only RTs in MAT, but also only those running the SMC on a day-to-day basis, had their daily commuting fares to SMCs financed by their management committee.

This evaluation of the RT practice leads to the general conclusion that RTs made an effort to implement all seven action points of SEITT. Such implementation tended to be lower than expected in all three provinces and throughout the three years of the study. Implementation also indicate a mixture of success and failure, and showed a pattern in the profile of implementation over the three years when activities started low key in 1998, increased relatively considerably in 1999, and were slightly reduced in 2000. Partnerships with EOs, pressure and support from stakeholders, and the addressing of teachers' real needs facilitated implementation whilst lack of time, missing incentives for RTs, and lack of financial compensation for expenses had a negative effect on RT implementation of their roles.

7.2.4 COLECT STUDY: THE POTENTIAL OF TEACHER-AUTHORED MATERIALS

A professional development practice such as the SEITT approach, where teachers are educated at a central venue through workshops, requires tools to bridge (or to facilitate transfer between) workshop discussions and classroom practice. Curriculum materials can serve this purpose (Loucks-Horsley et al., 1998). The SEITT approach incorporated CMW to produce materials that could serve this function. The COLECT study was designed to investigate the potential of such materials to facilitate teaching with understanding as advocated in PCK workshops. Materials from provincial CMW activities would have been ideal for such a study, but since such were not produced, the COLECT study adopted a physics module produced by the SEITT approach through a parallel writing programme executed at the national level. This study sought to answer the following research sub-questions:

- *How do teachers perceive the relevance and practicality of the module?*
- *How do teachers actually use the module and reflect on its major intentions in classroom practice?*
- *How do students experience learning using the module?*

Sampling involved a purposefully mixed sample of RTs and non-RTs. The researcher deliberately targeted five RTs who had showed themselves during training and workshops to be able teachers. To also explore how non-RTs would fare when teaching through this module, four non-RT teachers who had not yet taught the section covered by the module participated. The nine teachers altogether represented five regions and nine schools. Teacher perceptions of the module were investigated by questionnaire about a month before lesson observations and interviews with teachers and students were conducted.

Findings revealed that teacher perceptions on the contextualisation of subject content, practical activities, and pedagogical approaches were generally favourable. Teachers were, however, sceptical concerning the use of locally produced apparatus. Lesson observations and interviews showed the following.

- The module facilitated lesson planning and implementation due to the inclusion of procedural specifications.
- There was no recognisable difference between RTs and non-RTs in teaching performance–again attributed to the inclusion of procedural specifications.
- Contextualisation of subject content stimulated discussion and debate among students and between students and teachers in all observed classes.
- Most practical activities were executable but took too long for students to complete, resulting in a failure to complete lessons as planned.
- Subject content was consistent with syllabus expectations but students had problems drawing conclusions from practical work to make some concepts emerge from their data. Teachers gave notes to cover for this.

On the whole, teachers viewed the failure to complete lessons as planned as a characteristic of the teaching method. They forecasted that it would not be possible to complete the syllabus when the activity-based and learner-centred pedagogy was used. Teachers and students seemed to agree that the module facilitated teaching and learning, but could not stand alone as a teaching tool; they preferred to view it as complementary material to existing textbooks. The physics module, therefore, seemed successful with respect to the evaluation criteria but its acceptance as a tool for classroom teaching and learning was threatened because of the aforementioned teacher and student concerns.

7.3 DISCUSSION OF FINDINGS

In this section the results and conclusions of the four studies are discussed.

7.3.1 POTENTIAL OF THE SEITT APPROACH

The reconstruction of the SEITT approach came to the conclusion that the SEITT strategy was built from elements that had a recognisable base in teaching, learning and professional development. Important to note is the fact that the professional development plan emphasised teachers developing other teachers, a principle recognised in the literature as important (Barth, 2001; Fullan, 2001; Loucks-Horsley et al., 1998; York-Barr & Duke, 2004). Although this was the case, the question

remains whether all the elements of this multi-component plan were implementable, especially by RTs within the Zimbabwean environment. The following implementation outcomes can perhaps answer this question:

- PCK workshops indicated an example of what RTs could handle, and were therefore appropriate strategies in this scenario.
- The PCK-CMW linkage broke down at the initial stage in most cases suggesting that linkages between the various elements, especially when there was progress in one element depended to a large extent on proper implementation of the preceding stage. Classroom implementation was one adversely affected stage in the chain.
- Aspects of networking (especially IT) were beyond the control of the implementers. Connectivity issues were controlled by the country's discouragingly inadequate infrastructure, especially in the first two years of implementation.
- The approach was dependent on its implementers being multi-skilled. RTs already started with a deficiency in their skills base (e.g. CMW), making its wholesale implementation difficult.
- The ability to bring about change was dependent on all stakeholders having a common vision of the change (Field, Holden & Lawlor, 2000; Senge, 1990). Provincial vision did not appear to align with that of SEITT.
- Adequate time for implementation is crucial for the success of innovations (Darling-Harmond, 1999). Because of their full teaching loads RTs did not have much time.
- The approach had not considered the influence of the full range of related educational departments for change to be acceptable to teachers. This was the case with syllabus and examinations problems that teachers cited when rejecting the pedagogy of the physics module. The literature emphasises the importance of applying a systemic approach (Loucks-Horsley et al., 1998), with coherence between the various demands on teachers.

This plan was a typical example of attempting too much, which on one hand is known to increase the chance of success, but is at the same time risky, if proper implementation conditions are not fulfilled (Fullan, 2001).

7.3.2 ACTION PLANS AND FUNDRAISING

Implementation of action plans presented RTs with competing priorities between SEITT action points and those activities that addressed immediate, specific, and practical needs brought by teachers. The literature advocates a professional development that supports immediate teacher needs (Garet, Porter, Desimone, Birman & Yoon, 2001). The SEITT approach had allowed for this combination that,

nevertheless, demanded provinces to be flexible in their operation while at the same time maintaining focus. Due to time constraints, however, RTs had to choose which of the two to prioritise. Their choice resulted in immediate teacher needs displacing some of the SEITT action points. This made SEITT implementation even less orderly than it already was in their action plans. Such tension in implementation leads to the possibility that provincial level implementation of the SEITT approach did not share the same vision of the project as the architects of the project held. Findings by Fetters, Czerniak, Fish, and Shawberry (2004) indicate that when all stakeholders at implementation level do not share the vision, the resulting confusion leads to poor implementation.

Fundraising patterns showed that even with generally successful cases, implementation of action plans could not be made uniform over the three years. For instance, in one of the provinces, no funds were raised in the first year but in the second and third year, they exceeded set targets. In view of RT time constraints, unimplemented activities during the year when funds were not available could not be carried over and added as extras to the plans of that new-year. Excess funds due to non-implementation were absorbed by other activities or the administration. With this pattern of fund raising, it was not possible to implement action plans in a uniform way. This reveals that this method of funding provincial action plans could not be relied upon.

7.3.3 PCK WORKSHOPS

The purpose of PCK workshops was to raise the subject content knowledge of BEd/Licentiate holders and, the pedagogical knowledge of BSc holders, their pedagogical knowledge with the aim of raising both sets of teachers to a level rich in PCK. The third category of teachers (see 1.2.1) included teachers who, although they had a BSc plus a diploma in education, nevertheless, but mostly because they were still novice teachers, needed further development of their PCK. Shulman (1986) asserts that one of the characteristics of a good teacher is that he or she should possess a considerable amount of PCK. Based on workshop participants and the observations reported in this study, teachers seem to have appreciated the knowledge they gained from these workshops. Since change is essentially a learning process, PCK workshops appeared to have offered teachers opportunities to learning both new subject content and pedagogical content knowledge. In these PCK workshops, teachers appear to have latched onto each other's knowledge as they shared best teaching practices. In the absence of an organized networking

strategy as SEITT intended, PCK workshops, although to a limited extent, managed to get teachers to open up to each other and share, a practice that appears lacking in developing countries (Rogan & Aldous, 2005) where teachers seem to prefer isolation "for fear of exposing their areas of weakness." (p. 1187).

SEITT intended that PCK workshops were resourced by subject specialists from universities and industry as well as pedagogy specialists from colleges of education. This SEITT intention was aimed at presenting teachers with cutting edge and accurate knowledge in both science and pedagogy. RTs decided, on the contrary, to use each other as well as other teachers they considered knowledgeable, as resource persons. This view of each other was commendable since they recognized each other's strengths. This was a reasonable starting point, which SEITT had ignored. Given this starting point, it can be assumed that with time, teachers will realize a limitation in their collective knowledge and thus start to reach out for external help. This view of teachers is consistent with literature (Fullan, 2001; Rogan & Aldous, 2005) where it is argued that implementation is a step-by-step process that first takes into account internal strengths of the organization, just as the RTs and teachers first looked at the strengths among themselves before considering outside help. In these workshops, there was also failure to capture group understanding of PCK discussions through the writing of curriculum materials. The adaptation discussed earlier coupled with this failure made the outcomes of PCK workshops less transparent.

7.3.4 CURRICULUM MATERIAL WRITING

The project plan had intended that curriculum materials, as products of CMW, were to be the main vehicle for translating PCK activities into classroom teaching (see also Loucks-Horsley et al., 1998). Due to failure of this aspect, the project had missed the following:

- capturing, documenting, and disseminating collectively agreed teaching ideas as discussed in PCK workshops;
- production of materials that teachers identified as their own;
- translating PCK ideas at provincial level into practice at classroom level, something that can neither be replaced by RT notes (made prior to the workshop) nor individual participant notes.

The outcome of this component of the SEITT approach is hardly surprising given the perceived lack of writing skills by RTs as found in the perceptions study and the subsequent failure by SEITT to provide in-the-field training in writing skills. Based

on Lubben et al.'s (1995) findings, attempting to get teachers to write curriculum materials could have been a futile exercise. In the same study, however, these authors also state that their teachers accepted the writing role, but only after they realised the resultant materials were useful. In this case, the usefulness of materials could have challenged teachers to reconsider their positions, thus transforming what could have been external to internal motivation to write. SEITT RTs and teachers need to come face-to-face with something that challenges their position before they are motivated to write.

7.3.5 NETWORKING

The fate of networking in the SEITT approach was sealed when action plans consistently left this component out. Provincial implementation concentrated on electronic networking, which faced the problems of connectivity and computer illiteracy–made insurmountable by lack of training time and opportunities. Whilst teacher isolation was correctly diagnosed, the treatment could have been overambitious in the Zimbabwean environment. As has been said earlier, RTs were already overloaded by their own classroom duties, thus making implementation of such aspects of SEITT as networking too demanding on their time. Likewise, other teachers also lacked time and motivation, and in their spare time, appeared more interested in minding their own business than engaging in more teaching related activities. According to Lieberman (1996), networks are very demanding on the leadership, time, and creativity of its members and leadership with respect to solving the tensions that inevitably arise as the network is established and grows. Networks also require financial resources for their efficient management. Such conditions were not present in the environment of SEITT thus making initiation and maintenance of networks difficult. Whilst networks initially appeared a good idea to SEITT, the realities on the ground suggested that this strategy was, at least for now, impractical.

7.3.6 RESEARCH

According to RTs, classroom research was not initiated because it was supposed to be a collaborative activity with their university collaborators, who were also supposed to be the initiators of these activities. This failure means SEITT missed an opportunity to study and understand classroom practice more fully, since data from such research could have offered feedback into professional development and improvement of teacher interactions. The expected research in this area was mostly classroom based, especially designed to investigate how teachers were transferring PCK workshop ideas into their classrooms, and how students were benefiting from

such experiences. As RTs noted, such research is best done as a collaborative venture with university collaborators (see Sprinthall, Reiman & Sprinthall, 1996).

7.3.7 MANAGING SMCS

In the implementation of the SEITT approach, what SMCs achieved was dependent on what RTs focused on or what was practical during the three-year period. When RTs implemented PCK workshops, SMCs served their function to facilitate the planning and implementation of this activity. The general failure of other functions was due to a number of reasons. For instance, communication failed due to infrastructural difficulties, resulting in connectivity problems and what appeared to be a lack of interest by teachers. The events of 2002 in MAT (see section 5.3.7) show that what appeared to be a failure during the three years was not a failure after all. This was because teacher need to use such a facility had not arisen. Implementation of the 'meeting place for teachers' function failed as a result of poor planning by project designers. In this regard, SMCs proved to be out of the way for most teachers whilst the failure to satisfy the storage and distribution of the curriculum materials function happened because RTs had not written such materials with teachers. When materials are finally written, the SMC might still be there to fulfil this function. Whilst results indicate that some functions of SMCs cannot all be realised at the same time, others get eventually realised as the activities that generate those functions get implemented. This seems to suggest a phased implementation of aspects of SEITT, with each phase 'kicking in' when the environment can best support it.

The actual management of the SMCs role was performed well in those provinces that facilitated it through the provision of commuting expenses for RTs. When management committees could not make this provision, SMC management suffered and became a burden, usually for one or two RTs that taught at the SMC host school. These results could suggest that the format of SMC management was probably inappropriate, especially considering that RTs were constrained with respect to time and finances. A possible solution is releasing one of the several RTs per province on a fulltime basis to manage SMCs and attend to visiting teachers. Since SEITT is subject specific, this full time RT could also serve to facilitate subject meetings between teachers and their subject RT whenever this becomes necessary.

7.3.8 TRIAL OF A PHYSICS MODULE

The trial of the physics module produced a mixture of positive and negative messages about these materials. On the positive side characteristics of the material

such as contextualisation, facilitating hands-on activities, encouraging interaction between students and the teacher, and simplifying text language were viewed as stimulating teaching and learning with understanding. Chavunduka and Moyo (2003) found similar results for Zimbabwe whilst Jones and Baker (2005) found the same for New Zealand. Teachers accounted for their success in facilitating hands-on activities to the inclusion of procedural specifications. Specific advice for planning and lesson implementation served teachers time and frustration. Other research has reported similar success in instances where procedural specifications have been included in the materials (Ottevanger, 2001; van den Akker, 1988; Tilya, 2003; Voogt, 1993), especially those directed at overcoming initial implementation barriers. An equally important finding was the lack of difference in teaching performance between RTs and non-RT teachers, something that was again attributed to the inclusion of procedural specifications. This observation implies procedural specifications are able to raise the performance of non-RT teachers to the level of RTs. This was very encouraging, considering that the majority of teachers for which this module was prepared were not trained as RTs.

Learning to use the module exposed students' inability to draw conclusions from experimental data as well as teachers' inability to intervene appropriately. The haste to give students notes so as to provide them with 'more accessible physics' for examination purposes suggested resistance to the pedagogical style. Senge (1999) attributed the resistance in such situations to the fact that the innovation disturbed the existing state (providing notes) and thus elevated anxiety among teachers and students. Duran, McArthur and van Hook (2004) report a study with teacher training students where a lecture style physics course was changed and taught in a constructivist way. Students in the course complained of increased workloads and concepts that were expressed in ways that made it difficult to study for their examinations. Students expressed a wish to be given straightforward notes. Later, however, students changed their minds when they realised the usefulness of such experiences in their own teaching. The authors concluded that these student teachers had problems committing to the constructivist approaches to teaching. The module trial teachers and their students had this initial and likely continuing fear, since the anxiety was real and threatening. Teacher failure to complete lessons, which when projected, resulted in a failure to complete the syllabus in the long run was likely to disadvantage their pupils at examination time. Although teachers attributed this problem to the constructivist approach itself, the real cause seems to be the blending of constructivism with syllabi not designed for this approach. Van den Berg (1996)

highlights literature that states that syllabi for a constructivist approach should be made shorter to facilitate an in-depth understanding as opposed to including a broad and superficial range of topics. Such change in teaching methodologies, therefore, requires also changes in curriculum emphasis. In view of the normal practice where students still passed, albeit with average grades (see section 1.2.2 and 1.2.3), it was difficult for teachers to abandon note giving as a major way of passing on knowledge to their students. As has been observed by other researchers (Schneider & Krajcik, 2002) teachers need support, especially with lesson pacing and helping students during lessons. Such support could come in the form of peer coaching (Harvey, 1999; Kitta, 2004; Thijs, 1999). If, however, resistance is due to deep-rooted beliefs (Chaney-Cullen & Duffy, 1999; Munby & Russell, 1994) in the expediency of notes and lecturing, the way to bring change could be the one suggested by Black and Atkin (1996) and earlier illustrated by Munby and Russell (1994) where something drastic has to happen before teachers reconsider their position. Such a situation could be changed through testing that demanded higher order thinking and problem solving. Poor performance in such tests could make teachers realise their trusted teaching methods are not as effective as they thought.

Resistance to the SEITT case was directly related to the pressure put on teachers by external examinations, and hence the pressure to complete the syllabus. Examinations have been found to influence what teachers say, and choose to teach (Richardson, 2001; Sutton, 2004). Boardman and Woodruff (2004) found that examinations directly influenced the adoption or rejection of an innovation, and concluded that innovations that are not seen by teachers as assisting their students pass statewide tests run the risk of non-implementation. In the South African scenario, Rogan and Aldous (2005) found that pressure on teachers due to matriculation examinations was so high that teachers continued to emphasise near traditional modes of teaching instead of risking adopting more learner-centred strategies. In the SEITT case, the situation is similar to the one described by Rogan and Aldous and exacerbated by a curriculum that is considered too long for learner-centred teaching and learning to be practical. According to the literature (Fullan, 2001; Loucks-Horsley et al., 1998; Sparks, 1994), such problems arise from to lack of a systemic approach to project design. For a systemic approach, SEITT should engage all key stakeholders, including the curriculum development unit and the local examinations council, so that examination objectives and examinations are aligned to the new pedagogical style and the curriculum is not too long (see van den Berg, 1996). In view of this outcome, going for an all out constructivist approach was probably not a wise choice. This approach cannot be forced into traditional syllabi,

since as the teachers forecasted, completing the syllabus and preparing students for final examinations became extremely difficult. Also given the time it could take for MoESC to adapt syllabi, a project such as SEITT, without an indefinite lifespan, cannot expect to achieve all of this in its lifetime.

Some insight into causes of implementation resistance is also offered by Rogan and Grayson (2003) when they articulate the construct 'profile of implementation'. Paralleling their explanation with how try-out teachers and their students responded, resistance appeared related to the fact that teaching and learning was being required to take a 'quantum leap' from a scenario of teacher centred, subject focused teaching and learning (level 1) to student centred teaching and learning (level 4) in a relatively short time. These authors argue that a move from one form of teaching to another should be progressive with higher levels incorporating also the practices of lower levels rather than replacing them. Such changes need to be given time, with new practices being phased in at a rate teachers and their students are comfortable with. Taking note giving as an example, teachers were instead supposed to be encouraged to progressively reduce this practice, at the same time empowering their students to take over the task of note generation as they observed and made conclusions from hands on activities. Done this way, the change over becomes comfortable to both teachers and students, hence more likely to be acceptable.

7.3.9 DISCUSSING IMPLEMENTATION FACTORS

Implementation of the SEITT approach appears to have been generally and negatively influenced by the implementation strategy that was adopted. In this respect, Rogan and Grayson (2003) in the section on 'profile of outside support' state that encouragement for change is done at four levels. At the lowest level are bureaucratic, top-down directives and at level four change is effected through commitment by communities that share a common vision for the change. According to these authors, level one is necessary to kick start the change, whilst in level four, internal forces of an organisation take over, thus making the change sustainable. In the SEITT approach, the responsibility of internalisation of change requirements and implementation was placed on RTs. It became the responsibility of RTs, assisted by EOs and other education authorities, to professionally develop teachers, after which organisation for classroom implementation became the joint responsibility of RTs and in-serviced teachers. According to Rogan and Grayson, this level of operation fits in level four. What appeared missing in this implementation structure was monitoring, hence unclear accountability on the part of implementers.

Considering the problems RTs had (as summarised in this section), the SEITT approach may have tried to operate at level four prematurely. Whilst it appeared attractive for recognised authorities such as EOs to be on the implementation side with RTs, this arrangement took away from the system an already recognised monitoring mechanism. Since the research component was also weak, RTs had no feedback to facilitate monitoring of their own performance.

In the absence of bureaucratic pressure to implement, and faced with all the problems (time, teaching load, lack of incentives) already identified, the implementation barrier became too high. It would appear SEITT needed to work out a system where some form of bureaucratic pressure existed initially but eventually phased out as teachers were empowered and motivated to implement. At the same time, implementation barriers such as shortage of time, too much work load, lack of incentives, the too long syllabus, and with examinations that were not in line with the new teaching approach, should be were reduced.

7.4 METHODOLOGICAL REFLECTIONS

SAMPLING PROCEDURE

Purposive sampling was adopted for the evaluation study reported in chapter five and the COLECT study reported in chapter six. Such sampling was aimed at yielding as much information as possible since the aim of both studies was to learn from a promising practice rather than aiming for a generality of results, which would have required different sampling procedures. The most active implementers were likely the most interested in the project, and hence would have done their best to make implementation as successful as possible. The very limited implementation success has in fact made it apparent that the operational environment in which the SEITT approach was implemented was not conducive. This was true to the extent that even the most enthusiastic implementers failed in most aspects. On the whole this might suggest the professional development plan as a whole was difficult to implement, especially in the given environment.

RELEVANCE AND TIMING OF THE FORMATIVE EVALUATION

In the design process as discussed by Loucks-Horsley et al. (1998), reflection and redesign are considered important for the improvement of project design. The outcomes of this study seem to suggest that implementation of the SEITT approach lacked opportunities for such reflection and redesign. The results of this study have

pointed to a number of areas during the implementation of the SEITT approach that could have necessitated redesign or change in implementation procedures. Being the only systematic and on-going research within the SEITT approach, this very research indicated some aspects of the programme that had implementation problems but did not lead to any implementation or design changes.

The following accounted for this.

- Its results were always untimely. For instance, the results of this study always became available at a time when implementers were focused and well into the next stage of implementation.
- Implementers followed the project timelines and milestones set at the beginning of the project. Such a 'project progress' that did not, however, focus on results appeared necessary since donor release of funds for the next phase appeared related only to what was done and completed, and not what results were achieved.
- Even if implementers were willing to review implementation plans, or revisit and try to redo some of the activities, it is doubtful if the SEITT budget could support this.
- Time constraints. Even if funds were available, and implementers predisposed to rerun revised procedures, teachers hardly had time to do this.

Problems such as those outlined above, suggest that projects need to have flexible plans, as well as budgets and timelines that allow for formative evaluation and utilisation of feedback.

ROLE OF THE RESEARCHER IN THE ENTIRE PROCESS

The researcher played multiple roles in the entire SEITT scenario, ranging from project design of SEITT and co-ordinating its implementation to teaching in the RT diploma-training programme to researcher. As noted by researchers in similar circumstances (McKenney, 2001; Ottevanger, 2001; Stronkhorst, 2001; Tilya, 2003), such roles had their advantages, and at the same time posed challenges for research.

For this researcher, one distinct advantage was the accessibility of major stakeholders throughout the research period. In such meetings, it was possible to discuss the outcomes of research so that these people did not have to wait for formal reports, which, though providing useful feedback, were often untimely. Research sites and data sources were always accessible.

The following constituted challenges:

- *Researcher involvement in the object of evaluation*. At times during an observation an issue got so misrepresented that it was impossible to remain aloof (especially during workshop and class observations), lest the wrong message get conveyed to

participants. In all such cases, this researcher would respond accordingly but quickly withdraw to let the workshop/teaching activity continue. Because of this, the researcher at times got unavoidably involved in the very object of evaluation.

- *Researcher having interest in positive outcomes.* Due to attachment with the object of evaluation as co-designer of the project, the researcher would have liked implementation to turn out positively. It was, therefore, a struggle to remain objective, when most of the time, the outcomes were more negative than positive. Discussion with critical friends contributed to objective interpretation of results.
- *Socially desirable responses.* Due to familiarity between researcher and all respondents other than students, the possibility of obtaining socially desirable responses cannot be discounted. This was, however, kept to a minimum due to the use of multiple data collection methods and from a multiple base of data sources (Krathwohl, 1998).

Whilst the researcher remained as objective as humanly possible, a greater use of research assistants, as in some cases (COLECT), could have helped.

7.5 FINAL CONCLUSIONS

This study has shown, in general, that RT implementation of the SEITT approach was far less than optimal in most aspects of the SEITT approach. RTs implemented the approach relatively successfully in areas such as organisation and running of PCK workshops and needs analysis research. The ability to fundraise appeared dependent on other provincial assistance rather than purely RT effort, since EOs were also deeply involved with RTs in funding negotiations with SDAs/SDCs. It could also be inferred from what they did in organising and executing activities with teachers and running SMCs that they had, in general, developed leadership skills. Their preparation appeared lacking in areas such as CMW, networking, and more general research–success ranged from mediocre to non-implementation. RTs were, however, not wholly responsible for this poor to non-implementation scenario since, even though they had earlier articulated their inadequacies, SEITT failed to redress them in a timely manner. It is further concluded that facilitation of RT practice was rather limited and could have been improved through a comprehensive formative evaluation and feedback plan. The general aim of SEITT, to bring about change in teacher practice and hence improvement of teaching and learning, still needs a lot of work for it to be realised. Conclusions on the key elements of this study, *preparation of RTs, support of RT practice,* and *teaching and learning with understanding* are further highlighted below.

PREPARATION OF RTS BY SEITT

A prominent feature in the SEITT strategy is the development of resource teachers through a university programme that leads to a formal qualification. Whilst this strategy appears to have resulted in some positive outcomes (recognition of RTs by all stakeholders as qualified to lead other teachers), the centralised education at a university location appears to have its own weaknesses. For instance, the low level of implementation of the SEITT approach suggests that such education and training was not sufficient, on its own, to equip RTs with all the skills they needed to implement the SEITT approach. Although the low skills base of RTs was foreseen, despite the promises by SEITT co-ordinators to provide further in-the-field training, the delay in following-up this promise contributed to implementation failure. For SEITT the lesson to be learnt from this outcome is that formal education on its own is insufficient. Practical, in-the-field training with follow-ups and coaching is still essential for RTs to be fully functional.

SEITT SUPPORT OF RT PRACTICE

The findings of this study show sporadic evidence in support of RT practice by their university and MoESC colleagues as well as provincial directors. Where support was provided (PCK workshops and some instances of fund raising), success was relatively good. SMCs also played a vital supporting role for RT practice. Without them, it would have been difficult for RTs to manage organising the few activities they did. Where support was glaringly absent (such as in CMW, networking, and research) RTs met with very limited success. It would appear the degree of success was directly related to the amount of preparation RTs received and to the amount of support RTs received from various stakeholders. The operational environment, especially with respect to Internet provision, was not facilitative. This made communication between RTs and all stakeholders rather difficult. MoESC, as the key implementation partner and employer of RTs, did not have in place policies that promoted RT practice and such professional development. RTs, therefore, operated in a difficult environment that made successful implementation of SEITT elusive.

THE SEITT APPROACH IN GENERAL

The SEITT approach in general envisaged a flow of ideas ranging from theoretical understanding of professional development at university level, translated into the pedagogical content knowledge of teachers through the medium of RTs and PCK workshops, and finally into teaching and learning with understanding at classroom level facilitated by new teacher knowledge, skills, and curriculum materials. Other

elements such as networking, research, and SMCs were meant to facilitate this process. Although implementation did not go as far as was expected during the three years of this evaluation programme, some lessons can be gleaned from this limited practice. On the positive side, SEITT succeeded in making teachers agents of change and got teachers to start thinking about and acting towards the improvement of teaching and learning. SMCs and a variety of support materials now constitute the nuclei around which professional development of teachers can grow. On the other hand, a number of challenges for the implementation of such a strategy in the Zimbabwean context are now known to exist. First, the connectedness of the elements of the SEITT approach made implementation very complex since it became difficult to implement the various aspects effectively. Second, the designers underestimated the effort all stakeholders needed to make such a strategy become functional. Third, the designers underestimated what teachers needed to know to make the strategy functional. Fourth, the designers made a false assumption that formal RT education, on its own, was sufficient to make provincial implementation possible. Fifth, implementation at provincial level ignored the need to provide implementation pressure in the false assumption that support by educational hierarchy alone was sufficient for wholesome implementation.

FOCUS ON TEACHING AND LEARNING FOR UNDERSTANDING

All SEITT efforts were designed to result in teaching and learning with understanding. Whilst some effort was placed on PCK workshop implementation, which on its own was a big step in the right direction, failure to follow this up with CMW changed the intended flow of SEITT events, making any individual teacher implementation of knowledge gained in PCK workshops less transparent. The COLECT materials bridged this implementation gap, with the evaluation of these materials illuminating what classroom interactions were possible when such materials were used in classroom scenarios. Whilst in general, the COLECT evaluation indicated promising implementation outcomes, commitment by both teachers and students to teaching and learning using these learner-centred constructivist methodologies was lukewarm, and appeared threatened by the length and nature of curricula and focus of examinations.

7.6 RECOMMENDATIONS

POLICY

Some of the problems affecting implementation of the SEITT approach appeared related to insufficient or absent policy guidelines on professional development. The

following policy issues need to be attended to. First, a provincial vote specifically for professional development needs to be put in place so that RTs are freed to concentrate on issues directly related to the improvement of teaching and learning, as opposed to current practice where RTs also have to worry about the funding of their action plans. Second, RT practice needs to be facilitated through the reduction of teaching loads for appointed SMC managers and the specification of time during the year when mandatory professional development can occur. Third, during the process of appraising programmes such as SEITT, MoESC needs to fully understand their implications to education so that facilitative policies can be put in place. For instance, RT implementation was grossly affected by slow implementation of the policy on salaries and teaching load, which had still not been implemented three years into the programme. This study also revealed a need to reduce curriculum content and align examinations to a constructivist approach before changes in classroom practice can occur. Fifth, the COLECT study has shown that whilst we can invest in professional development of teachers through interactive PCK workshops, we can also improve teaching and learning through production and provision of high quality materials (see also van den Akker, 1988, 1994; van den Berg, 1996, 2001). We can also help teachers use these materials through provision of implementation support.

PROFESSIONAL DEVELOPMENT

The results of this study suggest a reconsideration of implementation of the SEITT approach with respect to the areas detailed below. Besides the time factor, RTs seemed to lack practical skills, which are important if professional development is to yield positive outcomes (Joyce & Showers, 1988). For each of the aspects of SEITT, the following recommendations are made.

- *RT education*. RT education also needs also to emphasise skills acquisition in environments similar to those of the intended practice (Putman & Borko, 2000) in all aspects of implementation. In view of the multi-component nature of the SEITT approach, RTs were not provided with all the skills required to implement such a complex plan.
- *Action plans*. Action plans drawn up by the provinces did not seem to reflect enough of what SEITT needed done in order to achieve its aims and objectives. As such, it is necessary for SEITT to consider implementation of a uniform action plan in all its provinces for a few years, and when implementation expectations have been mastered, then leave provinces to draw their own plans and timelines.
- *PCK workshops*. Whilst RTs appeared competent to facilitate this aspect, they still needed help with how to effectively capture and organise PCK ideas into curriculum materials. SEITT needs to facilitate this through demonstration and practice.

- *Curriculum materials writing*. Curriculum material writing by teachers is a very challenging activity that could not have succeeded under the conditions of SEITT. This is because RTs, despite professing ill preparedness for the writing, were still expected to organise and lead writing groups. This aspect is best done, even at provincial level, with collaboration between teachers and university partners (Duran et al., 2004).
- *Networking*. Although a good strategy for removing teachers from their isolation, networking, especially through IT, required learning of new skills by both RTs and teachers. In the case where RTs had no time to even do what they had fairly good skills in, it was better not to have included this strategy altogether.
- *Research*. The outcomes of research are important to inform practice. Assigning research to university personnel (in collaboration with RTs) was a good strategy that, however, did not materialise. Implementation of such programmes requires implementation deadlines and commitment to such deadlines by all concerned.
- *COLECT study*. Outcomes of the COLECT study have shown that teaching with exemplary materials demands coaching in the use of such materials at the classroom level (Fetters et al. 2002; Joyce & Showers, 1986; Kitta, 2004; Thijs, 1999), in which the coach provides support, feedback and assistance. Coaching appears particularly urgent as a support mechanism when teachers start using such modules as the one used in the COLECT study.

FUTURE RESEARCH

This study has focused mainly on RT preparation and support as RTs implemented the SEITT approach. Its results raise questions about RT implementation of their roles as well as the support structures of SEITT. With respect to Guskey's (2000) levels of evaluation, this study, due to its nature, lingered around the first three levels. For instance, questions on the effect of RT practice on teachers, and consequently on teaching and learning at classroom level, still need to be addressed. The COLECT study, for instance, was small scale and yet its results suggest a promising outcome. The area of curriculum materials writing at the provincial level, since it is a core emphasis of SEITT, needs further research to establish the role RTs play in this scenario and the kind of help necessary to make this important aspect of SEITT realise its objectives. Future research can extend the COLECT study to cover the other science subjects (biology, chemistry, and mathematics) of SEITT, including the scaling up of these studies with representative samples.

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IMPROVING SCIENCE EDUCATION IN ZIMBABWE: THE ROLE OF RESOURCE TEACHERS

SUMMARY

BACKGROUND

The war of liberation in Zimbabwe, among other things, brought universal education for all Zimbabwean children. Soon after independence, the new government followed up this need by opening up the primary education system. This move created a phenomenal increase in primary enrolments, which were soon followed by an equally phenomenal increase in enrolments in secondary schools. By the mid- to late eighties, the demand for school places had reached A-level. Along the whole chain of schooling levels, the expansion seriously challenged the education system with respect to the provision of classrooms, teaching personnel, and the equipment and materials for teaching.

At A-level, the shortage of teaching personnel was addressed through employment of subject-specialised university graduates (BSc graduates) who, however, did not have pedagogical training. Some training programmes, such as the BEd and Licentiate, were put in place to satisfy the teacher shortage problem in the shortest possible time. This quick fix solution resulted in a more difficult problem, that of teaching and learning with understanding. As it later turned out, the university subject content qualified teachers were very poor in pedagogical skills whilst the BEd and Licentiate teachers did not have enough of a grasp of subject content knowledge to handle advanced level science and mathematics classes. In the early 90's, this teacher qualification problem had started manifesting itself through A-level graduates, leading to institutions that absorbed these graduates to question their level of understanding of science and mathematics concepts. This societal outcry resulted in the Ministry of Education, Sport and Culture (MoESC) requesting the local university to run a professional development project targeted at improving teacher qualifications in order to facilitate teaching with understanding at this level. The Science Education In-service Teacher Education (SEITT) project resulted from this request.

The SEITT arsenal for attacking the problem of teaching and learning with understanding comprised five strategies: training teacher leaders called resource teachers (RTs) and facilitating their field operation; at provincial level, establishing and equipping science and mathematics centres (SMCs) to become the operational bases of RTs; a professional development package for teachers, and run by RTs, comprising pedagogical content knowledge (PCK) workshops; curriculum material writing (CMW), and; networking. As lead persons in this professional development scenario, RTs received formal, diploma-level university education whose intention was to equip them with the understanding of professional development theory and practice. The diploma education provided RTs with the qualification to work as specialists who provided professional development to their peers. Working as an integral unit, these SEITT strategies were expected, on the whole, to improve the subject content knowledge of BEd and Licentiate teachers, the pedagogical skills of BSc trained teachers, and to effectively equalise teaching qualifications of the A-level teaching force, thus setting them up to teach for understanding.

AIM, RESEARCH QUESTIONS, AND APPROACH

This study sought to enquire how RTs had been prepared for the task of professionally developing their peers. Whilst executing this duty, the study further sought to see how RTs went about implementing the SEITT approach and how they were facilitated in this endeavour. Data from this study facilitated reflection on the processes of SEITT approach. The study sought to answer the general question:

How successful was the SEITT strategy in preparing and supporting resource teachers in their facilitative role?

Four studies guided by a total of 11 sub-questions were conducted to answer this question. The first study reconstructed and theoretically appraised the SEITT approach in order to take a closer look at choices made in the design of the approach in light of literature on effective professional development strategies. This study was considered relevant in order to determine whether the SEITT approach was potentially powerful enough to bring about the desired change in teaching and learning. This study was done through a library search and desk study. The study addressed the sub-question:

Was the SEITT approach likely to yield its goals when viewed from international literature on effective professional development?

The second study focused on perceived RT preparedness to implement the SEITT approach by the RTs themselves as well as by key stakeholders in advance of actual implementation. It also focused on RT role understanding by RTs themselves and key stakeholders. This study provided a baseline from which to judge RT performance in the field. Data for the study were obtained by a questionnaire survey of all graduate RTs and interviews of EOs and heads of SMC host schools in the three case provinces. The study sought to answer the following three sub-questions:

1. *How well did RTs feel the diploma programme had prepared them for specific roles within the SEITT approach?*
2. *What were RT perceptions of their roles compared with those of the SEITT approach?*
3. *What were stakeholder perceptions of RT roles and function of SMCs respectively compared with those of the SEITT approach?*

The third major study sought to evaluate how RTs implemented the SEITT approach, and how the operational environment of RTs influenced their practice. This study provided the essential data on what RTs were capable of doing as well as how they were facilitated in the field. A longitudinal case study approach was employed and data was collected through interviews of a sample of RTs, teachers, and EOs, document analysis, questionnaires, and observations of SMCs and workshops. This study sought to answer the following four sub-questions:

1. *What was the quality of action plans drawn up by each of the three provinces?*
2. *How successful were provinces in fundraising to implement their action plans?*
3. *How were the following components of the SEITT approach implemented:*
    i. *pedagogical content knowledge (PCK) workshops;*
    ii. *curriculum materials writing (CMW);*
    iii. *networking;*
    iv. *research;*
    v. *science and mathematics centres?*
4. *In what ways did the environment of RTs influence implementation of the SEITT approach?*

The COLECT study constituted the fourth and final study. This study investigated how a physics module authored as part of CMW in the SEITT approach facilitated learner-centred teaching and learning. These materials were generally designed to facilitate teaching and learning through learner-centred methodologies adopted by teachers through the PCK workshops. The materials, therefore, acted as a bridge between PCK workshops and classroom practice. Data were collected from targeted

RTs and teachers through questionnaires, interviews, and lesson observations. The COLECT study aimed at answering the following three sub-questions:

1. *How do teachers perceive the relevance and practicality of the module?*
2. *How do teachers use the module and reflect on its major intentions in classroom practice?*
3. *How do students experience learning using the module?*

RESULTS

RECONSTRUCTION STUDY

In the reconstruction study, teaching and learning with understanding is placed, and appears to fit, within a constructivist perspective, where emphasis is not put on the knowledge prescribed by syllabi but on experiences that lead to that knowledge. The teacher's role is to facilitate activities that lead to acquisition of that knowledge. Suitable professional development in this scenario would therefore emphasise such teaching and learning and thus guide teachers towards attainment of the skills essential to make such teaching and learning a reality. A literature study of the individual SEITT components revealed that each component was designed to expose teachers and lead them towards embracing more learner-centred and constructivist approaches to teaching and learning. Consequently this study came to the conclusion that the SEITT approach had potential to realise its aims and objectives.

BASELINE STUDY

RT perceptions reflected the adequacy of training in most aspects of their expected roles. They were perceived adequately trained in organising and running PCK workshops, managing SMCs, doing research, and co-ordinating teacher networks. They were perceived inadequately trained in CMW. Such adequacy was associated with the practical nature of their training in these areas. These areas were also reflected positively in their perceived roles. These results suggested RTs were likely to implement well only those roles in which they felt most adequately prepared. Stakeholder knowledge of RT roles varied among stakeholder groupings, with the number of roles identified by either group (school heads and EOs) being less than those assigned to RTs by SEITT. Stakeholder perceptions of SMC functions were consistent with those of SEITT but also included the resource centre function where one of the RT roles, contrary to SEITT expectation, was that of reference librarian. It was concluded then that stakeholder knowledge of RT roles and SMC functions were consistent with expectations and did not vary too much with that of RTs to influence their operations.

RT PRACTICE

In relation to the seven action points of SEITT, RT practice yielded the following results:

RTs produced action plans throughout the three years of this study. The plans, however, varied in quality from province to province but on the whole were less detailed than SEITT expected. The frequency of such activities as PCK workshops was lower than originally intended, and IT workshops and research were generally left out whilst including activities outside those recommended by SEITT. Overall, the plans did not reflect wholesome implementation of the SEITT approach.

The level of success varied from province to province and from year to year. One province failed completely whilst one of the other two was average and the third one highly successful. All had raised funds from SDAs/SDCs, a source that was considered appropriate and sustainable. It was concluded that the fundraising component had the potential to meet provincial implementation plans.

PCK workshops covered those topics identified by teachers as difficult to teach, were interactive and facilitated knowledge, skills acquisition by teachers, sharing of ideas, and networking among teachers, but were less frequent and more spaced out than was intended. For these workshops, results also revealed—contrary to SEITT intentions—that RTs and teachers preferred to use each other as resource persons instead of outside specialists, believing they possessed sufficient knowledge and skills to professionally develop each other.

CMW workshops were few and far between, and were, contrary to SEITT intentions, generally independent from PCK workshops. Where attempts at CMW were made, the process took too long and eventually appeared to collapse at some point along the way. A more successful attempt involved writing of examination papers in MAN. RT workshop handouts supplemented by participant notes reached the classroom level. The project considered these two sets of materials inadequate since they carried individual interpretations of workshop proceedings, not the consensus view. The lack of time and writing skills contributed to this inadequate implementation.

Intended networking plans generally did not work, either through lack of interest in writing with respect to magazines, or because of poor infrastructure, inaccessibility of computers, limited RT and teacher skills in the use of computers, and the

problems of meeting telephone bills for each centre with respect to IT networks. Teachers, however, achieved considerable networking through PCK workshops.
Research appeared limited to workshop evaluations and need analyses for the professional development needs of teachers. The expected research collaboration between RTs and their university colleagues had not yet happened.
SMCs successfully facilitated PCK planning and implementation as expected. Due to inaccessibility, they failed to facilitate the use of reference materials by teachers, as well as IT communication by both teachers and non-resident RTs.

COLECT STUDY

CMW was intended to produce transfer documents that bridged workshop ideas with classroom implementation. The physics module, as one such document was designed, was used in classroom practice to investigate how such materials facilitated teaching and learning. This study was nicknamed the COLECT study. Its findings were as follows:
The module facilitated lesson planning and implementation due to the inclusion of procedural specifications. Students were able to set up the apparatus and perform most activities under guidance of the module instructions, thereby indicating the readability of the module. These two findings attested to the practicality of the module.
Teachers acknowledged that their lessons had become livelier than normal, with increased class discussions and more students participating in the lesson. Students perceived an increase in their understanding of physics content as a result of using the module.
One piece of apparatus did not perform as expected, causing problems for both the teacher and students. For the most part, and across all classes:

Students had such problems drawing conclusions that intended concepts did not emerge as well as was expected. Teachers generally did not help students draw good conclusions, preferring instead to issue notes that contained what they thought was expected knowledge. The contextualising story was mostly used only as an introduction to the lessons. Failure to complete lesson plans was prevalent in observed classes, an apparent result of teachers' poor time management. Teachers attributed this to the need to exhaust discussions (especially during introduction) or to allow students to complete activities. Teachers viewed this as a characteristic of the teaching method, and predicted that it would not be possible to complete the syllabus when the activity and learner-centred pedagogy was used. Teachers and students seemed to agree that the module could not stand alone as a teaching tool,

with teachers arguing for their notes whilst students argued for the use of both the module and their conventional textbook, with the module facilitating practical activities and regular text books providing the concepts.
There was no difference in planning and teaching performance between RTs in the study and their non-RT counterparts, something that was attributed to the inclusion of procedural specifications.

CONCLUSIONS

This study has shown, in general, that RT implementation of the SEITT approach was relatively successful in organising and running PCK workshops, in needs analysis research, and to a limited extent, fund raising. They had problems implementing CMW, networking, and more general research. Lack of all round success was attributed to lack of time, since teachers had to continue full time, money for travel, incentives, the need to pay for the implementation of their action plans in the absence of successful fundraising, and skills, since their education and training lacked follow-up training and coaching. With respect to the key elements of this study, the following conclusions are drawn.

Preparation of RTs by SEITT: Formal training presented RTs to all stakeholders as academically qualified to be doing what they were doing. RTs were also empowered to work (in general) with other teachers, especially in the organisation and running of PCK workshops. The low level of implementation of the SEITT approach suggests that such education and training was not sufficient on its own to equip RTs with all the skills they needed to implement the SEITT approach. Follow up in the form of coaching appeared necessary.

SEITT Support of RT practice: RT practice enjoyed the support of all stakeholders in general. They were, however, let down in a number of areas. Their University collaborators were slow to implement follow up training and to initiate some collaborative activities like research and materials writing. The ministry of education, though willing, was slow to implement the one notch salary incentive for all graduate RTs, slow to reduce RT teaching workloads, and slow to implement the appointment of four RTs per province to run the SMC. As a result, RTs were overloaded with work, and in most cases, were not refunded expenses they incurred when doing SEITT work. Generally, support of RTs during the evaluation period was predominately moral, whereas RTs needed materials support as well.

The SEITT approach in general: The flow of ideas starting with the academic education and training of RTs at University, the education and training of teachers by RTs, through the pedagogical content knowledge workshops of teachers and other activities, and finally translating into improved classroom teaching and learning as envisaged by SEITT did not proceed as expected. From the implementation of SEITT in general, the following can be concluded. On the positive side, SEITT succeeded in making teachers agents of change as well as getting teachers to start thinking about and acting towards the improvement of teaching and learning. SMCs and a variety of support materials now constitute the nuclei around which the professional development of teachers can start to grow. The following challenges, however, also exist. First, the connectedness of the elements of the SEITT approach made implementation difficult since it became difficult to implement the various aspects effectively. Second, the designers underestimated the effort all stakeholders needed to make for such a strategy to become functional. Third, the designers underestimated what teachers needed to know to make the strategy functional. Fourth, the designers made a false assumption that formal RT education, on its own, was sufficient in making provincial implementation possible. Ignoring on-the-field skills training of change agents negatively affected transfer of PCK ideas into teaching and learning at classroom level.

Teaching and learning for understanding: The conduction and content of PCK workshops held considerable promise for adapting teaching and learning practice to achieve SEITT aims and objectives. The failure, however, to produce materials from PCK workshops in order to bridge group knowledge with classroom practice constrained transfer of acquired knowledge and skills to classroom level. Implementation of the COLECT study indicated that these SEITT produced materials had characteristics that enabled both teachers and students to implement learner-centred teaching and learning in a way that the programme intended. Realisation of the potential of these materials was dependent on policy changes to align the A-level curriculum and A-level examinations with such a teaching approach.

APPENDIX A
THE DIPLOMA PROGRAMME

This is an official university programme used to educate and train resource teachers in the SEITT project. Its objectives are given in section 2.4.

The programme is taught over a two-year period during school vacations. In year one, the programme includes four coursesx–philosophical, psychological and sociological foundations of INSET, as well as research methods. In year two students do curriculum design, implementation and evaluation, instructional design, and a research project. Year two courses are practical and designed to teach students the skills they need in their workshop programmes, research activities and classroom practice. Both years culminate in three-hour examination papers for each course taught. The key feature of the programme is the education of RTs in relevant professional development theory and practice. The Joyce and Showers model (1988) of professional development is used as a basis for workshop scenarios. Teamwork is heavily emphasised in this programme. Two major field activities are included in the programme, and these are briefly described.

1. Live Student Workshops

These workshops are planned for and practised during residential periods at university. Students take these workshop plans to their provinces where they use them to organise live workshops for teachers. Students are collectively assessed for logistical planning and individually assessed for actual workshop performance. Workshop participants complete an evaluation questionnaire. Students are expected to analyse the questionnaire and write a short reflective report of the workshop. This exercise ends in a residential period after provincial teams have shared their workshop experiences. Student workshops are assessed and the marks contribute towards the final student grade.

2. Research Activity

In year two, students generate and present a research project report. For the research, each student identifies a classroom practice problem, or any school problem that involves teachers. Students then research on this problem and then present a research report for grading.

APPENDIX B1

RESOURCE TEACHER QUESTIONNAIRE

1. Province……..... 2. Teaching subject.....

3. Gender.....

4. Qualifications. Tick all the qualifications that apply to you in the boxes below.

DipScEd(Inset)	Licentiate	Bed	BSc	GradCE	Masters
□	□	□	□	□	□

5. How long have you taught your subject at A'level after obtaining professional qualifications?

2 -4 yrs	5 -7 yrs	8 – 10 yrs	11 + yrs
□	□	□	□

6. Are you currently teaching in schools or at a college?

Schools	College	Other
□	□	□

7. The following questions refer to the resource teacher (RT) concept.

List in **order of importance** what you believe are the roles of an RT (you may **rank** some or all of the following roles and add some that you think have been left out.)

Researcher, subject specialist, inset specialist, PCK workshop organiser, Teacher network co-ordinator, curriculum material writer, SMC manager, resource librarian …

i ……... ii ……... iii ……... iv ……...
v ……... vi ……... vii ……... viii ……...
ix ……... x ……...

8. Do you feel that the PGDipScEd(Inset) course adequately prepared you to;

	Yes	Partly	No
Prepare and run PCK workshops?			
Manage SMCs?			
Write curriculum materials?			
Co-ordinate teacher networks?			
Do research?			
Source human and material resources for your INSET programme?			

9. Respond to the following nine questions by ticking under the most appropriate box. If you feel that "writing minutes of management committee meetings is the responsibility of the RT" then tick the box under RT. (Note: MC = management committee; HOHS = head of SMC host school; BSP = Better schools Programme.)

Whose responsibility is this?	RT	MC	HoHS	BSPZ
Sourcing funding SMC equipment				
Maintaining SMC inventory				
Researching teacher needs (needs analysis)				
Preparing and running workshops				
Producing annual report on SMC activities				

The following questions refer to science and mathematics centres (SMCs).

10. In your region is there much support for the SMC concept by the following people?

	Yes	No
Provincial director?		
Education officers?		
Head of your own school?		
HOD of your own school?		
Fellow science/mathematics teachers at your own school?		

11. Is your SMC within reasonable distance from your school? ☐ Yes ☐ No

12. How many times per week is it practical for you to spend some time at the SMC? ..... times.

APPENDIX B2
INTERVIEW GUIDE FOR SCHOOL HEADS & EOS

(Used with school heads, education officers and some parts with the regional director)

1. Perceived RT roles
   In your view what do you see as the roles of resource teachers in this province?
   (Follow up on each role mentioned)

2. Perceived SMC functions
   In your view what do you see as the functions of science and maths centres in this province?
   (Follow up on each function mentioned)

3. Questions specific to the SMC
   a) SEITT has worked in close collaboration with the ministry of education to establish a science and mathematics centre in your region. *Could you tell me what you think about the physical structure of the SMC in your region?*
   b) Does the SMC idea developed to date meet with your expectations?
   c) How is the idea being received in general by teachers?
   d) Does the idea seem to fit within existing education structures?
   e) What is the ministry's position on the development and operation of SMCs?
   f) As the SMC stands, do you see it promoting the meeting and exchange of ideas by teachers on a regular basis?
   g) How do you think the SMC idea can best promote the professional interaction of teachers?

Development, running and quality of workshops

   a) From what you have heard or seen concerning workshops that have been held so far, are teachers confident with the kind of resource persons that they have been getting?
   b) Does the content dealt with so far in workshops appear to be useful in the classroom?
   c) At least one subject workshop has been held this year. In your view, was the organisation and execution properly done *(timely announcements, strategic times and execution dates and venues).*

d) Do you think these workshops are having the effect of improving the performance of teachers in the classroom?
e) Do the workshops held to date address the needs of teachers?
f) Are resource teachers following up their workshops so that they can benefit a wider spectrum of teachers as well as improve what actually goes on in the classroom?

Do you have any other thoughts you might want to share with me on Science and mathematics centres? Resource teachers?

APPENDIX C1
INTERVIEW GUIDE FOR TEACHERS

A. General information

(Province, gender, subject, classes taught, school, teaching experience in years)

B. About SMC

1. Do you consider the physical arrangement of your SMC to be adequate? What would be most ideal? What factors contribute to what it is?
   What would be most ideal?
   What factors contribute to what it is?
2. How accessible is your SMC?
   Have you used the centre yourself on a regular basis?
   What kind of things do you do when you get into the SMC?
3. Are all installed facilities working?
4. How accessible is the funding to run activities at the SMC?
5. Do you consider your SMC to be a good venue for workshops?
   What about in terms of availability of lab space for workshops?
   On which days do you normally do your workshops?

C. PCK workshops

1. How many workshops run under SEITT have you attended this year?
2. What was the theme of the (*subject*) workshop you attended?
3. Do you know how the RTs adopted this theme?
   Did they address something you consider to be useful?
   Have you used some of the ideas from the workshop in your teaching?
4. Was the workshop well attended? (collect a list of workshop participants)
5. What have been the general comments of your fellow teachers on the workshops you have attended so far?
6. Do you consider the majority of these workshops to have been successful?
   Would you like to see more workshops related to the areas addressed?
7. What is the nature of follow up that has been made to each workshop, i.e. getting teachers to adopt workshop ideas and use them in their classroom?
8. Do you personally find workshop ideas applicable to your own teaching situation?
9. What do you hope to gain by attending these workshops?
10. Have you gained anything so far?

D. Curriculum material writing

1. Have you carried out any CMW workshops?
   (If yes, probe what they are writing on and how its progressing. If no, find out why)

E. Networking

Probe what network activities are being done (idea exchange through magazines, newsletters, IT etc.)

F. Rating of RT performance by fellow teachers

How do you rate your subject RT in terms of:

1. Workshop preparation?
2. Content delivery?
3. Enthusiasm for his/her role?
4. Ability to motivate?

APPENDIX C2
INTERVIEW GUIDE FOR RTS

A. General information

(Province, gender, subject, classes taught, school, teaching experience in years)

B. Programme activities

Which activities on your action plan have you carried out? Why? (and why have you not carried out other particular activities?)

C. PCK workshops

1. How many workshops have you carried out this year?
2. What has been the theme of each workshop? How did you get to choose this theme?
3. Have the workshops been well attended? (collect a list of workshop participants)
4. What have been the general comments on the workshops you have held so far from classroom teachers?
5. Do you consider the majority of these workshops to have been successful?
6. What kind of follow up have you made to each workshop so far? What are you planning to make?
7. What is your ultimate aim in running these series of workshops?
8. So far do you think you will realise your aim?

D. Curriculum material writing

1. Have you carried out any materials writing workshop(s)?
2. What did you do? How was it done?
3. How successful was it?
4. Comment on the writing (if any) that is going on.

E. Networking

What networking activities did you carry out this year?

How successful was (……..) your computer workshop? (if action plan indicates that it was done).

F. SMC

1. Do you consider the physical arrangement of your SMC to be adequate? What would be most ideal? What factors contribute to what it is?
2. How accessible is your SMC?
3. Are all installed facilities working?
4. How accessible is funding to run activities at the SMC?
5. Do you consider your SMC to be a good venue for workshops?

G. Research

1. Did you carry out any research this year?
2. In what area?
3. What was your research problem?
4. Have you completed the research?

H. Other

What other factors do you think are working?

1. For the success of your workshop and SMC programme?
2. Against the success of your workshop and SMC programme?

APPENDIX C3
INTERVIEW GUIDE FOR ADMINISTRATORS

(Used with school heads, education officers and some parts with the provincial director)

A. General information
(Province, gender, school/office)

B. Resource teachers

C. SMC

1. SEITT has worked in close collaboration with the ministry of education to establish a science and mathematics centre in your region. *Could you tell me what you think about the physical structure of the SMC in your region?*
2. Does the SMC idea developed to date meet with your expectations?
3. How is the idea being received in general by teachers?
4. Does the idea seem to fit within existing education structures?
5. What is the ministry's position on the development and operation of SMCs?
6. As the SMC stands, do you see it promoting the meeting and exchange of ideas by teachers on a regular basis?
7. How do you think the SMC idea can best promote professional interaction of teachers?

D. PCK workshops

1. From what you have heard or seen concerning workshops that have been held so far, are teachers confident with the kind of resource persons that they have been getting?
2. Does the content dealt with so far in workshops appear to be useful in the classroom?
3. At least one subject workshop has been held this year. In your view, was the organisation and execution properly done *(timely announcements, strategic times and execution dates and venues)?*
4. Do you think these workshops are having the effect of improving the performance of teachers in the classroom?
5. Do the workshops held to date address the needs of teachers?
6. Are resource teachers following up their workshops so that they can benefit a wider spectrum of teachers as well as improve what actually goes on in the classroom?

E. Do you have any other thoughts you might want to share with me on:

1. Science and mathematics centres?
2. Resource teachers?
3. Logistical problems?

APPENDIX C4

WORKSHOP OBSERVATION GUIDE

Date of workshop ……
Facilitator ……
Province ……

	Before the workshop	**Yes**	**No**	**Notes**
1	RT has workshop plan			
2	RT has handouts ready			
3	RT has materials for activities ready			
4	RT is in room before the participants			
5	RT generally appears ready and composed			
	Introduction			
6	RT introduces himself			
7	RT asks participants to introduce themselves			
8	Discussion of successes and failures in applying previous workshop ideas			
9	RT states objectives of content workshop series			
10	RT explains objectives of workshop			
11	RT explains procedure of workshop			
12	Resource person introduced if any?			
13	Workshop theme explained			
	During the workshop			
14	Topic teaching difficulties discussed			
15	Topic learning difficulties discussed			
16	Learner centred theory underpinning procedure			
17	Demonstration			
18	Practice in a reduced setting			
19	Evaluation/discussion of activity			

	Before the workshop	Yes	No	Notes
	SEITT Procedures			
20	Person other than RT guiding topic presentation			
21	Other teachers contributing heavily to topic presentation			
22	Teacher activities translated to student activities			
23	Related student exercises discussed			
24	Writers' group set up			
25	Group members allocated tasks			
26	Writing programme set up			
	Other observations			
27	Teachers work in groups			
28	Groups given opportunities to discuss among themselves			
29	RT/resource person dominates workshop			
30	RT/resource person issues handouts			
	Concluding activities			
31	Previous writing group progress discussed.			
32	Workshop evaluation performed			

APPENDIX C5
TEACHER SATISFACTION LEVELS IN PCK WORKSHOPS

Table C5.1: *Summary of teacher reactions to workshop content*

	MAT *(n=38)*	**MAN** *(n=22)*	**MASH** *(n=28)*
Questionnaire item:	Mean	Mean	Mean
Rate this workshop in terms of:			
Topic covered.	4.6	4.5	4.4
Content coverage.	4.5	4.0	4.1
Relevance to syllabus.	4.8	4.7	4.4
Relevance to yourself.	4.7	4.8	4.3
(Average of mean)	4.7	4.5	4.3

Scale: 5 = very good; 4 = good; 3 = neutral; 2 = Poor; 1 = Very poor.

Across all three regions teachers rated the indicated aspects of their workshops with a minimum of good. These results carried the general perception that workshop content was relevant to teachers, had good content knowledge coverage, and directly addressed syllabus requirements.

Table C5.2
Perceived relevance of PCK workshop

	Percentage of YES responses			
	MAT	MAN	MASH	
Question	*(n = 38)*	*(n =22)*	*(n = 28)*	Mean
Did you learn new subject content?	97	91	88	92
Did you acquire new skills?	95	100	76	90.3
Will your teaching improve?	97	100	89	95.3
Will you attend next workshop?	100	100	100	100

APPENDIX D1
MODULE STRUCTURE

At key points between the five lessons students are presented with discussion questions, which they first do as individuals, then in groups, and finally as a whole class. These questions are meant to test concept acquisition, and for both the teacher and student, gauge learning progress. Figure D1.1 contains sample student questions and next to it, some teacher guide hints.

Student guide	**Teacher guide**
1. Using the equation, period, $T = 2\pi \sqrt{m/k}$, for an oscillating system where *m* is the mass of the bob and plunger and *k* is the spring constant, find the frequency, *f,* of the oscillator. Explain how you did this. 2. What would be the effect of the water on the oscillating system? How can this effect be minimised? 3. Using the knowledge you have gained so far, what would be the best position to place the oscillator if the results are to be valid? Explain your reasoning	**Suggested time (10minutes for all three questions including discussion)** 1. Note that students will need to measure mass, *m* of the bob as well as know the spring constant, *k*. Make available a good chemical balance for the mass and provide a figure for *k*. 2. Damping problem. Use small oscillations or make the plunger narrow or …… 3. Be open to accept reasonable suggestions from students. It is important, however, that they accompany their suggestions with plausible explanations.

Figure D1.1: Discussion Questions

Since not all concepts can be developed efficiently through hands on activities, the module includes some sections that have theoretical presentations of concepts. But even then, the text interacts with the student as shown in figure D1.2.

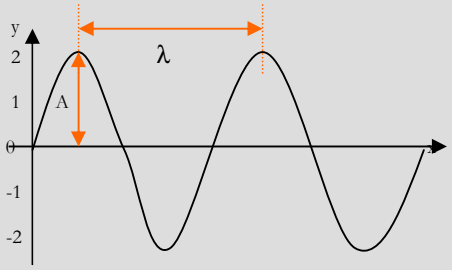
Student guide	Teacher guide
 Figure 10.4(c) The distance between two successive crests or troughs or any two points that are in step (phase), is the wavelength (λ) as shown in figure 10.4 (c). A cycle is complete if two successive crests or troughs have gone past a given position. Frequency is the number of complete cycles per second. Period, *T*, is therefore inversely proportional to frequency, *f*. $T = 1/f$. What would be observed if two floats are placed as illustrated in fig. 10.4(c) i. ¼ of a wavelength apart. ii. ½ of a wavelength apart. iii. A full wavelength apart.	For students to understand the concept "phase" difference of two wave particles, it is important that answers to questions i – iii are illustrated visually. Mechanical systems designed to illustrate periodicity in SHM can do this very well.

Figure D1.2: Sample presentation of theoretical concepts

In the last of the five lessons, the learned concepts refer back to the contextualising story to enable students to understand the concepts in context. The final section of the module then presents examination type questions to test student learning. Figure D1.3 illustrates how the contextualising story is used to conclude the lesson series.

Student guide	Teacher guide
We can now refer back to figure 10.0 (Farai's fishing experience with grandpa) and point out the following: (i) The illustration shows regular pulses emanating from where the stone(s) are hitting the water. This gives the impression that we have a periodic wave generator! When **one stone hits the surface of the water, only one circular pulse is generated.** (ii) You need a **periodic pulse generator**, like a vibrating hacksaw blade or oscillating spring, to generate **periodic pulses**. (iii) With points (i) and (ii) in mind, what should Farai do to generate periodic pulses. (iv), (v), (vi), (vii) (viii) If Farai were to throw 10 stones periodically in a period of 10 seconds, at what frequency would Farai be operating? (ix) Suppose Grandpa were a physics professor and Farai could understand, how would you, as Grandpa, respond to Farai's mistaken observation of a bobbing float for a biting fish?	**Special assignment** Turning question (ix) into an essay for students would be a fun way of displaying understanding. Students who comes up with a story that has the most number of concepts and correctly contextualized becomes the winner. A most suitable prize is an honours list, or a badge that rotates among winners.

Figure D1.3: The contextualising story in scientific language

APPENDIX D2
TEACHER QUESTIONNAIRE

Dear physics teacher,
A team of A-level teachers operating under the umbrella of SEITT programme has authored a short exemplary module on wave phenomena. The module covers section 10 of the physics syllabus. The authors have attempted to present physics teaching in a way that maximises student participation in the teaching and learning process. You are hereby asked to review these materials. A series of questions has been asked to guide your review. Please complete the questionnaire as fully as possible and return your completed evaluation in the addressed and stamped envelope enclosed.

Section A
Complete this questionnaire by either ticking inside the box where such is provided or writing in the spaces provided.

1. Your province: ……
2. Name of your school: ……..
3. How long have you taught 6th form A-level physics? …… years
4. Are you a SEITT trained RT? ☐ Yes ☐ No

About the student text
5. How did the majority of your students respond to the fishing story?
   (i) Illustration ☐ liked it ☐ did not like it
   Reasons for the answer above
   ……
   (ii) Story itself ☐ relevant ☐ irrelevant
   Reasons for the answer above
   ……

6. How good is activity 1
   (i) In illustrating ä ripple generator, water ripples, float, movement of water ripples, etc"?
   ☐ good ☐ poor
   (ii) Is the activity practical enough in your environment?
   ☐ Yes ☐ No

7. Activity 2a
   Which aspect of this experiment did you find difficult to implement?
   ……
   What difficulties were cited by your students in implementing this practical exercise?
   ……

Theory section (pp. 5-7)

8. (i) How well does this section define concepts of wave motion?
   ☐ Very well ☐ Poorly
   State and explain any section you have reservations on
   ……
   (ii) How well does this section treat wave concepts compared to similar sections in standard text books?
   ☐ Very well ☐ Poorly
   Any particular reason for your response above?
   ……...……

Design activity 2c

9. Is the activity as suggested in the teacher's guide practical to perform?
   ☐ Yes ☐ No
   What do you suggest?
   ……
10. Does exercise 10.2 cover A-level concepts to the correct depth?
   ☐ Yes ☐ No
   What do you suggest?
   ……...……

About the teacher's guide

11. Does the teacher's guide offer useful suggestions?
   ☐ Yes ☐ No
   What else would you like to see included in the teacher's guide?
   ...……

12. On the whole, how did you find this set of teaching materials?
   ☐ Good ☐ Poor

13. What do you think are the advantages of teacher- produced materials compared to commercially available text books?
   ……
   ……

Thank you

APPENDIX D3
STUDENT QUESTIONNAIRE

Please respond to all the questions asked below. Your own individual opinion is being sought therefore do not discuss your opinions with someone else whilst answering this questionnaire.

Concerning the student text

Item number	Question	Yes	No
1	Did you enjoy reading the 'fishing with grandpa' story?		
2	Did the story get you to start thinking about waves?		
	The following questions concern the activities and exercises in the student text. Respond to all the questions.		
	Activity 1		
3	Did you find activity 1 worth doing?		
4	Did you learn anything from doing it?		
5	What did you learn from this activity? …….. ……..		
	Activity 2 (a)		
6	Did you find activity 2 (a) easy to do?		
7	If your answer to (6) is no, what did you find difficult? …… ……		
8	Now that you've done it, would you rather the teacher described the activity, and given you an exercise that enabled you to do the calculations and then move on		
9	Did actually doing the activity help you to understand the concepts better?		
10	Do you think learning through these activities increases your practical skills?		
11	You did most of the work as a group. Would you still say the teacher was teaching?		
12	You did most of the work as a group. Would you rather work alone?		
13	What is the reason for your answer? …… ……		

Item number	Question	Yes	No
	Concerning the student guide		
14	Was it easy to follow the instructions in the student guide?		
15	Explain your answer to question 14 …… ……		
16	Does the student guide cover all the concepts outlined in your syllabus?		
17	Given a choice, would you rather (please circle the letter that represents your choice) A. use similar student guides for all topics? B. use your standard text book all the time? C. use all two together?		
18	Give a reason for your answer to question 17 …… ……		
19	What would you suggest the authors of this module do to improve it? …… ……		

APPENDIX D4
LESSON OBSERVATION GUIDE

		Yes	No	notes
	Lesson pre-requisites			
1	Teacher has lesson plan ready			
2	Teacher has required apparatus ready			
3	Teacher has handouts/teacher guide			
	Orientation to learner centred teaching			
4	Students seated in groups/ organized into workgroups			
5	Students have copies of student guide			
6	Students engaged in discussion within 1st five minutes			
7	Lesson objectives are outlined			
8	Key concepts are explained			
9	Handling of equipment briefly explained			
	Lesson management			
10	Teacher refers to real life story (Farai's or alternative)			
11	Teacher introduces activity			
12	Students set up apparatus using instructions in guide			
13	Students who have difficulty setting up apparatus are assisted			
14	Teacher encourages all students to participate in apparatus manipulation			
15	Majority of groups manage to set up apparatus from instructions in guide			
16	Teacher moves around stimulating students to think about what they are doing			
17	Teacher asks questions that relate activity to theory			
18	Teacher poses problem situations that student groups have to answer.			
19	Students encouraged to co-operate to solve problems			
20	Students provided sufficient time to work through exercise			

	Conclusion
21	Student groups take turns to discuss activity challenges
22	and solutions found
23	Real life applications of activity discussed
24	Teacher gives notes that cover lesson concepts
25	Homework provided is one suggested in guide
26	Alternative homework similar to one suggested in guide
	Classroom management
27	Teacher effectively handles discipline
28	Teacher paces lesson ensuring smooth progression of lesson
29	Teacher completes lesson plan
30	Students appear comfortable working mostly independent of the teacher
	Overall impressions
31	A hands on-minds-on lesson
32	Teacher dominates lesson

Notes:

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APPENDIX D5
POST LESSON INTERVIEW GUIDE WITH TEACHERS

1. Could you tell me how you feel about this lesson.
2. How different was this lesson compared with your other lessons when the module is not used?
3. What aspects of the lesson did you like, not like, and why?
4. Do you notice any difference in behaviour of your students when using this module compared to other lessons? (if differences exist, ask why).
5. What aspects of this method do you find easy, difficult to implement?
6. What do you notice are the pros and cons of teaching and learning using this module approach?
7. What in your view would be the problems, if any, if you were to teach the whole A-level syllabus using this approach?

Post lesson interview guide (FGD) with students

1. Do you like using the physics module? What do you like about it?
2. How do lessons done using this module differ with other lessons you normally have?
3. Which of the two types of lessons do you prefer? Why?
4. The first lesson in the module is introduced with a story. Do you think the story was a good introduction to waves? Why do you say so?
5. In what ways do each of the following help you learn, if at all;
   (a) Discussions with the teacher?
   (b) Discussion among yourselves?
   (c) Working in groups or as teams to solve problems?
   (d) Doing a lot of hands-on activities?
6. When do you feel you understand physics better, now when you are using this module or before? Why do you say so?
7. Which of the two teaching approaches do you prefer, using this module or some other way? Why do you say so?

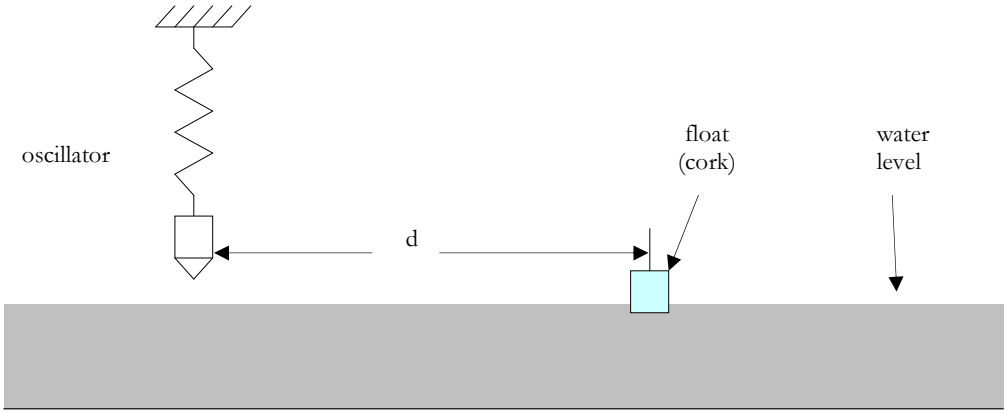
APPENDIX D6

ACTIVITY 2A

Activity 2a

Objective: Through this experiment you should be able to determine the speed of water waves.

(a) Your group should use the apparatus provided and set it up as shown in figure M.
Make sure that the oscillator just touches the surface of the water.



b. Displace the oscillator so that the plunger dips into the water. Release the mass so that it makes small oscillations of amplitude ± 1 cm. Discuss what happens to the cork.
c. Determine the time for ten oscillations of the cork. Describe how you do this.
d. Make measurements of 20cm< d >70cm.
e. Discuss and choose a suitable method to determine *n*, the number of wavelengths that fit within distance *d*.
f. Determine λ by $\lambda = {}^{d}/_{n}$, where *n* is the number of wavelengths passing the cork.
g. Use the equation $v = f\lambda$, where *f* is the frequency of oscillation and λ is the wavelength, and your results to calculate the velocity of the water waves.
h. Discuss and suggest improvements to this experiment.