CHAPTER 1

GENERAL INTRODUCTION, STATEMENT OF THE PROBLEM AND OVERVIEW OF THE STUDY

1.1 Introduction

The global and local societies we live and work in are transforming at an intense rate and in ways often not anticipated or even imagined. Paradigms guiding our thinking and doing have to be fluid in that they freeze, unfreeze and reorganise to adapt to the diverse and multiple flexible needs and demands of a post-modern world. The field of Education and Training is by no means an exception to this volatile reality and finds itself in the midst of transformation, particularly in South Africa.

Following the 1994 elections, South Africa embarked on a programme of social and economic reform that is officially referred to as the Reconstruction and Development Programme (RDP). The key purpose of the RDP is to set in motion structures and mechanisms that will promote the redress of inequalities left behind by the legacy of non-democratic governance prior to 1994. A key component of the RDP is the transformation of the education system. The education transformation agenda in terms of its organisational, legislative and governance frameworks, which were put in place during 1995, is underpinned by the following principles (Department of Education, 1999:18-19):

- **Equity and redress**, especially in the equitable provision of finances and resources.
- **Access** to basic education for all.
- **Quality** in terms of providing learners with learning opportunities of an acceptable standard.
- **Efficiency**, to ensure optimal value for the considerable financial and other resources which are invested in education.

- **Democratic participation** in the governance and management of education institutions and the sub-system as a whole.

- **Sustainability** of development initiatives, so that they will contribute to overall transformation in the long term.

- **Relevance** of education to the needs of the economy and individuals' vocational aspirations, as well as broader social and cultural values.

The following paragraph from the White Paper on Education and Training (1995:15) highlights the objectives of transformation in South African education and training:

> *Successful modem economies and societies require the elimination of artificial hierarchies, in social organisation, in the organisation of and management of work, and in the way in which learning is organised.*
>
> *They require citizens with a* ***strong foundation of general education****, the desire and ability to continue to learn, to adapt to and develop new knowledge, skills and technologies, to move flexibly between occupations, to take responsibility for personal performance, to set and achieve high standards, and to work co-operatively (Own bold print).*

At school level, the transformation gained impetus when the Minister of Education announced an important public milestone on March 24, 1997 – the launch of Curriculum 2005. Curriculum 2005 is the framework for reform of the school curriculum and was proposed to be phased in from grade 1 through 9, which constitutes the general education phase referred to in the White Paper. The initial intention with Curriculum 2005 was that by the year 2005 the new curriculum would be implemented across the first 9 years of schooling. The educational reforms in Curriculum 2005 and all other forms of education and training in South Africa, are built on the vision and principles of **outcomes-based education** (OBE).

One of the key aspects of the outcomes-based Curriculum 2005, is that learning will be organised in eight Learning Areas, rather than in traditional subjects. One of the Learning Areas that came into existence with Curriculum 2005 is **Technology**. The introduction of

OBE in general, and the introduction of technology education in particular, has created the need for teachers to develop a new philosophy about teaching and learning, as well as a range of new teaching competencies. It is expected that teachers will learn about the new paradigm and obtain new competencies through pre-service and in-service teacher education programmes.

The term "teacher education" will be used when reference is made to the overarching programme associated with a whole qualification. The term "teacher training" will be used when reference is made to a sub-programme within the qualification programme. In South Africa, part of the transformation policy promotes the integration of education, which used to be more academically orientated, and training, which was vocationally orientated (French, 1997:17-31). French continues to explain that the principle of integration *"is a political strategy to ensure foundational structures that will never allow an easy slippage back into the class system, the privileging/marginalising that happens in the split between education and training"* (1997:19). Within the spirit of the transformation, it seems that these two terms may be used interchangeably in the South African context.

This thesis describes research that investigated one way of empowering teachers to meet the new challenges of teaching technology in particular, but also physical science and other Learning Areas within an OBE framework. The research was conducted in two contexts: first, within a pre-service education programme designed to provide pre-service teachers with the knowledge and skills necessary to teach about technology through a **problem-based learning (PBL) curriculum and strategy;** second in authentic school classrooms where the pre-service teachers attempted to apply their newly acquired competencies.

To provide a background for this research, some key issues related to technology, technology education and teacher training in this area according to the new paradigm, are identified in the following sections of this chapter. This leads to the formulation of the research problem and research questions which will direct the rest of the research. The final sections of this chapter will briefly summarise the proposed research design and methods. The last section will also sketch the preliminary significance of this research in the field of pre-service teacher training in South Africa.

1.2 The importance and impact of technology on the global and local society

The impact of inventions, discoveries and creative innovations of technology, integrated with science and mathematics, are apparent in all spheres of life. The fast expanding realm of technology is one of ever increasing importance in the information age. Technology is acknowledged by most as the single most powerful driving force in the world, since it penetrates every aspect of work, play, private and public life.

Countries who want to do more than survive now and in the future, who want to lead and compete in the global economical environment, are also dependent on technological prosperity and the technological capabilities of their people. This relationship between technology and economic-prosperity was emphasised by President Clinton in 1993 when he introduced his technology policy as follows:

> *Technology is the engine of economic growth. In the United States technological advance has been responsible for as much as two-thirds of productivity growth since the Depression. Breakthroughs such as the transistor, computers, recombinant DNA and synthetic materials have created entire new industries and millions of high paying jobs. ... Investing in technology is investing in America's future: a growing economy with more high-skill, high-wage jobs ...and an inspired scientific and technological research community focused on ensuring not just our national security but our very quality of life* (Dyrenfurth, 1995:2).

This link between technology, economic growth and the overall development of a country is a common driving force for educational reforms. For example, it was central to the political arguments that drove education reform in Australia in the early 1990's (Killen, 1998a) and it is a key issue in South Africa's current educational reforms (National Education Policy Act, 1996).

Referring to the role to be played by technology, Shield (1996) remarked that technology in the modern world provides a self-fulfilling imperative, in that all citizens of a modern state should know all about and understand the role of technology. Only by becoming a life-long learner in the field of technology, will people function effectively in societies which are technologically driven.

The American National Science Foundation (NSF) pointed out that traditional curricula, especially traditional science and mathematics, are inherently not suited to develop the technological capability of their youth. They said that "... *literacy standards for twenty-first century society are expanding beyond the traditional three R's into science and technology*" (NSF, 1983: August 3). Learners will need more than the body of knowledge and skills provided by traditional science which has been practiced world-wide from a positivist world view as a value free endeavour. Yager (1995:18) contends that *"students in science classes are more knowledgeable about technology than they are of basic science concepts and processes ... technology provides a tie to most current problems and can provide the link between science and peoples' lives"*. The "technologization" of science is promoted by Kahn & Volmink (1997:7) as a practical means of revitalising the school science curriculum and addressing the gap in technology education.

It is often argued that if South Africa is serious about reducing poverty, unemployment and all the negative social effects associated with them, it must seriously become competitive in the global economy, drawing on a technological literate and highly skilled work force (ANC, 1994). Ntuli, then chairman of the national technological career development agency PROTEC's Executive Committee, reinforces this argument when he concludes that "*unless we invest in improving the pool of technologically skilled South Africans, we will not recover fully from this or any subsequent recession...We must develop a strong, world class technology base to generate jobs and wealth needed to sustain our people*" (1992:3). It is necessary to realise and embrace the urgent importance of technological enhancement as the base of economical prosperity and global competitiveness. It is just as necessary to realise and embrace the fact that the **education system**, formal or non-formal, stands at the base of economical prosperity, since it is the route to employment of an appropriately educated and skilled workforce.

The Organisation for Economic Co-operation and Development (OECD) acknowledges the vital role to be played by education. To realise their primary vision of developing the world economy, the OECD founded as one of their initiatives the Centre for Educational

Research and Innovation (CERI) in June 1968. The main objectives of this educational centre are:

- to promote and support the development of research activities in education and undertake such research activities where appropriate;
- to promote and support pilot experiments with a view to introducing and testing innovations in the educational system;
- to promote the development of co-operation in the field of educational research and innovation (Black & Atkin, 1996:i).

None of the policies or objectives of the OECD specifically mention mathematics, science or technology education. However, in 1989 when the OECD group started a six-year educational research study, the situation analysis pointed to a common need in all the different countries:

> *The fields of mathematics, science and technology called for new innovations to be planned, orchestrated, implemented and evaluated, because educational change in (these) subject areas are vital to every country's future* (Black & Atkin, 1996:2).

This initiative by the OECD once again acknowledges the fact that the future of nations will increasingly be built in the classrooms of those nations. It is here that beliefs, essential understandings, personal career ideals and capabilities are cultivated which will advance the economy, society and the individual. Only as recently as the mid-nineties has technology education, also known by other names, invented itself in the national curricula of different countries in the world. The following paragraphs will trace the roots of technology education in different national curricula.

1.3 International and national perspectives on technology education

Substantial insight can be gained and lessons learnt from international endeavours and experiences with a relatively new Learning Area in curriculum, technology education. Technology education is offered in more than 50 countries in some way or another in school curricula. Different social, political, financial and historic-cultural considerations have determined how technology education was conceptualised, designed and implemented in different countries varying from developed to developing countries.

The justifications for including technology in different national curricula ranged from broader attitudinal ones seeking to value the practical, to attempts to promote economic competitiveness, to some pure educational ones focusing on the technological design process which might enhance problem-solving skills. By reviewing some of the international trends, it is possible to place South African educational reforms in this field, into a broader context. The section to follow will highlight some international trends, but it is not meant to be comprehensive. It will, however, where applicable make special mention of problems or initiatives experienced with pre- or in-service teacher education, since this study has an interest in this field.

1.3.1 International perspectives on technology education

In many countries, technology, unlike subjects such as physics, chemistry, biology and earth sciences, does not have a long history and the same status as these subjects. Only during the past decade have several options emerged to deal with technology in primary and secondary schools. Three basic options have emerged in different schools in various countries. The first option is to introduce technology as a new subject into the curriculum. A second is to add technological topics to the science curriculum. A third option is to develop science, technology and society (STS) courses to replace, or be added to science courses (Medway, 1989 and Layton, 1993).

In the *Netherlands*, technology was introduced in 1993 as an obligatory subject for all learners in junior secondary schools (Black & Atkin, 1996:57-58 and Eijkelhof, Franssen & Houtveen, 1998:677). This initiative was chosen to be the Dutch contribution to the OECD Science, Mathematics and Technology Education Project. Prior to 1993, a pure craft orientated version of technology was in use in their vocational schools. Some of the schools still prefer to take the craft-vocational route. The new subject, technology, had a variety of aims which can be summarised as follows (Eijkelhof, Franssen & Houtveen, 1998:679):

- Familiarising pupils with technology to
  - be prepared for further technical studies;
  - function effectively in society;
  - understand technologies of particular cultures (indigenous technologies).
- Learners acquire knowledge and understandings in the three main pillars of technology (energy, matter and information) and in close relationship with natural sciences and society in order that
  - they can become actively involved in producing technology and innovations;
  - they can learn to use technological products;
  - they can explore their abilities and interests in the field;
  - boys and girls are offered equal opportunities.

For the Dutch secondary schools, the Dutch Technology Teachers' Association, together with allies from industry and academic fields also proposed to launch technology as a separate subject (Van Aalst, 1995). This proposal did not receive much support. Instead it was decided to integrate technology into subjects such as mathematics, chemistry, physics, biology and general sciences. Apart from the integration some technological skills have been added to the science curriculum, such as

- recognising a technological problem;
- developing a design;
- constructing based on this design;
- evaluating this design and the construction process;

- making proposals for improving the design.

The OECD/SMTE study results showed that one of the problems which will have to be conquered when integrating science and technology is the lack of co-operation and communication, due to competition between science and technology teachers. A solution suggested, is to create a single science and technology department with one head, who should be responsible for co-ordination across the curriculum and who could negotiate with administrators and local industries on behalf of the whole department (Eijkelhof, Franssen & Houtveen, 1998:689).

In 1988 *British* Parliament passed the Education Reform Act that created their National Curriculum which also accommodates technology as a separate subject. The structure of their curriculum consisted of four key stages of compulsory education for years 5 to 16. The curriculum consisted of core subjects, i.e. mathematics, science, English and foundational subjects, where technology was included. It was decided that this new subject would be known as "design and technology" to emphasise the interconnectedness of these two concepts (Barlex, 1992:20). The new subject intends to bring together several curriculum areas which were previously taught separately.

According to Stables (1996) one of the major needs and problems with the implementation of this new foundational subject was that very few of the teachers who had to teach design and technology received formal training in the teaching of the subject. The rapid introduction of this new subject meant that teachers from home economics, business economics, science, art, craft and design were called upon to teach this subject. Currently there is a back-log of unprepared technology teachers teaching this subject and this has led to a lack of cohesiveness and sometimes negative experiences with the subject.

It would appear then, according to Barlex (1992:24), that to help teachers to move forward in this subject, considerable in-service training is required and it should focus on

- developing teachers' conceptualisation of technology;

- developing their confidence in their ability to build creatively on their previous experience in other subjects;

- providing teachers with personal hands-on technological experiences and the opportunities to share it with colleagues before they try it out with learners.

In *Israel* the subject "Integrated Technology" was introduced as a junior high school subject in 1994 and the new "Integrated Science and Technology" was introduced in intermediate schools in 1996 (Verner, Waks & Kohlberg, 1997). Integrated Technology in senior high school beyond grade 10 is not compulsory. The curriculum is divided into general, technological, vocational and religious bands. Currently, the technological schools provide education to approximately half of all secondary learners. Subjects which learners may choose from in technological schools include electronics, machinery, specialisation in computers and agriculture.

In *Australia,* approaches to technology education vary from state to state. As an example, in the state of New South Wales, technology education is a component of the Science and Technology Learning Area in the K-6 syllabus. In 1996 an evaluation was undertaken of the Science and Technology K-6 syllabus and the Support Document (Board of Studies NSW, 1995-1997). The evaluation involved 38 primary schools throughout New South Wales, 555 teachers and 38 principals were interviewed. Cognisance may be taken from the following conclusions from the research results (Board of Studies NSW, 1995-1997):

- The technology component was not fully understood by teachers at the time of the evaluation and seems to have a "mid-range" status.

- Curriculum integration with content from English and/or Human Society and Its Environment was very common.

- Programmes tend to favour content relating to natural and physical sciences (living things, physical phenomena, the earth and its surroundings) and it appears that less emphasis is given to technology units (products and services, information and communication).

- As a result of the issues mentioned in the previous point, priority is given to the process of investigation and less to designing, making and using technology.

- Teachers recognise the need for ongoing professional development in Science and Technology and require support especially in the following areas:

  - Accessing supplies of consumable resource materials.

  - Curriculum integration units with English, Human Society and Its Environment.

  - Background information on science and technology concepts.

At the secondary school level, technology is part of the Technology and Applied Studies Learning Area. Design and Technology is a subject within this Learning Area and is compulsory for learners in years 7 and 8. In years 9 and 10 learners can select other technology related subjects.

In the early years (1989-1992) of the introduction of technology education in Australian schools, the major problems were the limited in-service training of specialised teachers, and the reluctance of teachers to embrace the new methodologies of teaching associated with the teaching of technology. The new types of methodologies referred to are learner-centred, experiential-based learning, as well as enterprise learning which is learner defined and orientated towards problem-solving, meeting needs, discharging responsibility and centred around real projects (Morgan, 1992:133-134). The secondary schools which implemented technology education successfully in the early years of 1987 in Western Australia, contributed their successful implementation to continuous co-ordination, monitoring and assistance for technology teachers by an on site technology co-ordinator who had enough time to manage the implementation and drive the process. The funding for the on site technology co-ordinator was originally provided by the Ministry of Education and not by the individual schools (Treagust & Rennie, 1990).

In the *United States of America* it is proposed that technology be integrated in the science and mathematics curriculum. Three projects have been initiated which proposed models for science and technology education. Two of the projects, *Educating Americans for the 21st Century* (1983) and *Project 2061* (1983) came from the science fraternity namely the National Science Foundation (NSF), while the project *A Conceptual Framework for Technology Education* (1983) came from technology educators. These projects were set up in 1983 in an effort to regain the USA's technological lead over the rest of the world. As was the case in the United Kingdom, the best school learners in the USA compared well to those in Japan, but the majority (90%) at that time performed much worse than the majority of learners in Japan (McCormick, 1992:40). These initiatives were also stimulated by the concern with the poor performance of learners compared with those in Japan in international tests, such as the Third International Mathematics and Science Study (TIMSS) which was written in 1995-1996.

This concern called for constructive inputs resulting in the NSF and NASA funding a project called *Technology for All Americans* (NSF, 1983). A panel of experts in science, technology, mathematics, engineering and technology education, developed standards for a technologically orientated curriculum. The standards were developed around the notion of technological needs for school-to-workplace articulation, technological literacy for all and the need to provide education for those interested in advanced technological careers.

Canada decided on a *technology-across-the-curriculum* approach. Chinien, Oaks & Boutin, (1995) found in their research, that there was a need to integrate technological literacy across school curricula from K-12. It was also advised that technology should be integrated into all grade levels and all subjects, beginning in kindergarten, from very traditional technology to emerging sophisticated technology. An evaluation report stated that while technology was implemented on a large scale in Canadian schools, only 50% of the teachers had some type of retraining intervention in technology. This failure to provide adequate teacher training in technology education, it is warned, may have a devastating impact on the implementation of technology education, since teachers are the main change agents of any curriculum (Chinien, Oaks & Boutin, 1995).

In *Africa, Botswana* has implemented the "Design and Technology" approach from the United Kingdom. Most of the African countries have implemented technology within the context of integrated science and vocational studies, which is also mainly the trend in the Pacific rim where the entire education is more vocationally orientated (Kahn & Volmink, 1997:5-6). The reason, it is speculated, is that in most developing countries the main objectives with technology, which is actually more technically orientated, is to stimulate learners' interest in technical careers. By doing this learners are prepared with pre-vocational skills and attitudes required for work in industry, agriculture and other production sectors.

The trend in the rest of Africa is to reinstate the traditional, sometimes called indigenous, technology that has always existed – a technology associated with the improvement of the environment and habitat, with handicrafts, peasant trades and farming techniques. The purpose for doing so is not to oppose the imported modern technology. It is rather done to develop appropriate technology which can build a bridge between the traditional technology and sophisticated industrial and information technology, which is unsuitable to the predominantly agricultural societies on which it is imposed (Unesco,1983).

This brief overview indicates several distinct approaches to technology curricula and the implementation thereof in various countries. It also highlights several common problems which should be avoided and used as lessons to learn from for future implementation of this Learning Area. The most important problems seem to have been a lack of clarity in the definition of technology education and the conceptualisation thereof within a particular country's context. Another major problem is the failure to provide adequate in-service training for teachers who had to be retrained for technology education. These issues will now be examined within the South African context.

1.3.2 National perspectives on science, technology and mathematics education

1.3.2.1 Problems and difficulties facing mathematics, science and technology education in South Africa

The terrain of science, mathematics and technology, as well as education in these areas, have been researched and investigated in detail by various studies over the past years in South Africa. A key issue which proved to be problematic for decades now, is the high proportion of un- or under-qualified teachers on whose shoulders lie the responsibility for the nation's education in these areas. Another threatening problem is the inadequate supply of teachers in these subject areas (Kahn, 1994). Approximately 1350 secondary school mathematics and 1000 secondary school science teachers qualified in 1996 with some form of qualification, such as an advanced certificate, diploma or degree with specialisation in teaching in these subjects. Approximately one quarter of the qualified mathematics and science teachers altogether, hold a university degree (EduSource, 1997:2-3). These numbers are not nearly enough to cater for the educational needs in these areas as will be seen when the attrition rate is discussed later in this section.

An analysis of the number of students currently registered in mathematics and physical science related subjects at tertiary institutions, geared towards education, indicates that there will not be a significant increase of teacher numbers entering the schools over the next three years (EduSource, 1997:3). The attrition rate is significant for determining the number of teachers who need annually to enter the profession to balance the number leaving. The average attrition rate in all subjects, across primary and secondary schools, is 6%. In mathematics and science, the rate of 15% is far higher than the overall average. One reason for the high attrition rate of mathematics and science teachers is the fact that there are several other employment opportunities with much more attractive salaries outside of the teaching profession.

The average class size in these subjects is often greater than 40. If this number is to be reduced, even more teachers will be needed. It was also estimated that for the period 1997-1999 the annual deficit would be approximately 3000 mathematics and 3600 science teachers. That is to meet the targets of decreasing class size and improving the annual attrition rate. In this same period the output of qualified mathematics teachers was approximately half of the number needed to replace the annual attrition rate of 15%. In science the situation looked worse, where the output is only 40% of the number of science teachers required to replace the annual attrition rate (EduSource, 1997:3-4).

As early as 1981 the expansive National De Lange Investigation on Educational Provision (HSRC, 1981:45) came to the following conclusion:

> *The great demand for persons who are trained in Mathematics, Physics, Chemistry, Mechanics and Electronics or who have anything from an elementary to an advanced knowledge of these subjects necessitates that the current high drop out rate in these subjects should be considered afresh. From a curriculum perspective it would appear that attention should be paid to curriculating for* ***Functional*** *Mathematics, Physics, Chemistry, etc.* (Own boldprint).

still exists. Against the background of this picture the White Paper on Science and Technology (1996) argues that government has the responsibility to promote these areas and to provide incentives for disadvantaged groups to study mathematics and science and to achieve computer literacy, as well as to put a national system of innovation in place.

A recent research report sponsored by the Danish International Development Agency on *the Demand, Utilisation, Supply and Training of Science and Mathematics Teachers* (1997) actually mirrors the problems and findings of the De Lange Investigation.

The report *"Mathematics and Science Teachers: Demand, Utilisation, Supply, and Training in South Africa"* (EduSource, 1997) reports extensively on the findings regarding the utilisation, demands, qualifications and teacher-learner ratios in all the different provinces in South Africa. It must be noted that when this research was undertaken, technology education had not yet been implemented in South African schools. The enormity of the problem is highlighted by data that summarise the qualifications of science teachers (Table 1.1) and mathematics teachers in South Africa (Table 1.2):

Table 1.1 Qualifications of teachers in science across the provinces in South Africa

Subject Qualification	Teachers qualified in science	% of total science teachers (n = 14 107)
Three or more years university course	1 192	8 %
Two-year university course	360	3 %
One-year university course	701	5 %
Higher Diploma of Education (science)	427	3 %
Secondary Teacher's Diploma (science)	3 208	23 %

Subject Qualification	Teachers qualified in science	% of total science teachers (n = 14 107)
Total Qualified	**5 889**	**42 %**

(EduSource, 1997:33)

This data indicate that only 42% of the science teachers have been formally trained in science, with over half of those having gained their science qualifications through Secondary Teacher Diploma courses. These figures constitute very low levels of subject specialisation and expertise.

Table 1.2 Qualifications of teachers in mathematics across the provinces in South Africa

Subject Qualification	Teachers qualified in mathematics	% of total mathematics teachers (n = 15 697)
Three or more years university course	1 401	9 %
Two-year university course	633	4 %
One-year university course	893	6 %
Higher Diploma of Education (science)	576	4 %
Secondary Teacher's Diploma (science)	4 284	27 %
Total Qualified	**7 787**	**50 %**

(EduSource, 1997:33)

The figures for mathematics educators are a fraction better than that of the sciences. Not surprisingly, the state of affairs regarding not enough adequately qualified teachers in the natural sciences and mathematics reflect in learner achievements across the grades, as the following discussion will point out.

Towards the end of 1996 the national and international results of the Third International

Mathematics and Science Study (TIMSS) were released. The TIMSS is the largest and most ambitious international study of mathematics and science achievement ever undertaken. The study was initiated by The International Association for the Evaluation of Educational Achievement (IEA) which is based in The Netherlands. The primary aim of the IEA is to gain a better understanding of the effects of policies and practices within and across different systems of education. Since its inception in 1959 the IEA has already undertaken 15 cross-national achievement studies (Howie, 1996:1).

The results from the South African survey will be discussed in this next section. The South African sample school group was randomly selected and was fully representative of all provinces, urban and rural communities and race groups. 5 301 grade 7 (standard 5) and 4 491 grade 8 (standard 6) learners were tested. The results of TIMSS carried out by the Human Science Research Council, placed South Africa at the ***bottom of a list of 41 countries*** in terms of learner achievement in mathematics and science by grade 7 (standard 5) and grade 8 (standard 6) learners. Singapore ranked the best in both mathematics and science, while Korea came second, followed by Japan and Hong Kong in the mathematics section. These results once again focused attention on the crisis in mathematics, science and technology education in South Africa.

It might be argued by critics that conclusions drawn from TIMSS are not strictly fair, since most of the tests were not written in the vernacular of most of the learners. Tests were written in English, and it is known that English is poorly employed at the grade 7 and 8 level at schools, especially in rural schools in the remote areas of the country. It is further said that the tests did not really test a country's school effectiveness, since the variation between test items based upon material in or outside the prescribed syllabi, showed little variation. An interesting correlation to note though, is that the highest scoring countries have a high degree of industrialisation, while lowest scoring countries all have a very large basic agricultural sector (Kahn & Volmink, 1997:4). If the TIMMS performance of the representative South African learners was so unsatisfactory, the prospects for technology education in South Africa, especially for those in the informal, remote rural and informal agricultural sections, might be even worse.

The picture regarding the problems facing science and technology education in South Africa is by no means complete without also mentioning the following aspects (Bawa, 1994:3 and Kahn & Volkmink, 1997:5):

- The fragmented, exclusive education legacy of the past, resulted in only 1/60th of African (Black) learners with the subjects, mathematics and physical science, passing their final school grade 12 examination, with exemption. For learners to pass with exemption, they need to have particular combinations of subjects, a prescribed number of these subjects have to be on the higher grade and they must achieve a minimum mark in the subjects. For learners who had to take some of their subjects on the standard grade, a minimum mark is also prescribed which is usually 10% higher than the higher grade mark. Learners who have passed with exemption, may continue with their higher education at universities. Learners who did not get exemption may continue their higher education at other tertiary institutions such as the technikons and other vocationally orientated institutions, and may enter a university at a later stage if they possess appropriate levels of prior knowledge.

- In 1990 only 8% of African students who wrote matric obtained matric exemption.

- The early differentiation (at age fourteen) in formal education where learners need to select a subject combination in either a general (social), economical or natural science field, forces a social science – natural science lopsidedness. This results in low levels of scientific-technological literacy.

- South African school curriculum development was prescribed by the needs of university degrees – therefore there was no pull towards technology components in curricula, since universities do not offer the subject "technology" as an equivalent to subjects such as anatomy or chemistry.

- The nature of teaching and learning at school level in the absence of adequate and sufficient teacher education, became heavily dependent on the "textbook-lecturing" style in many schools which resulted in rote-learning and other forms of "banking" which are not conducive to critical and creative thinking, problem-solving and innovation.

It is against this background that educational transformation and reconstruction, especially in the field of science and technology, had to be introduced. A myriad of investigations into possible reconstruction and development paths resulted in the following documents:

- National Education Policy Investigation (NEPI), 1992. The object of this investigation was to interrogate policy options in all areas of education within a value framework derived from the ideals of the broad democratic movement.

- The 1993 ANC policy conference on science and technology training (September 1993).

- White Papers on Reconstruction and Development (4 September 1994) and Education and Training (March 1995).

- The ANC's document on Implementation Plan for Education and Training (ANC, 1994:1) stated that science curricula

  ...is academic, outmoded and overloaded. Applied science and technology as well as the social and ethical aspects of science are excluded. Only 12% of higher education students pursue degree and diploma programmes in engineering and the life, physical and mathematical sciences.

- A discussion document on a Curriculum Framework for General and Further Education and Training (December 1995). The discussion document (December 1995: 1) states clearly that while providing relevant, quality basic education for all, ***"increased attention (should) be paid to areas such as mathematics, science and technology as ways of preparing the nation for the future".***

- The White Paper on in Science and Technology: Preparing for the 21st century (1996).

1.3.2.2 The history of technology education in South Africa

The roots of a technology project actually date back to the old dispensation before 1994 where initiatives were launched to introduce technology as a school subject. Prior to 1994 technology was offered as "design and technology" mainly in advantaged schools by some provincial education departments such as the ex-Natal Education Department.

Disadvantaged schools and communities depended on the service provided by non-governmental organisations (NGO's) with the names of ORTSTEP (ORT-Science and Technology Education Project) and PROTEC (Programme for Technological Careers) for exposure to some form of technology education (Kahn & Volmink, 1997:1).

In 1992, the previous National Department of Education introduced the Curriculum Model for South Africa (CUMSA) document to attempt transformation in education. Technology was included as a school subject and a core syllabus committee was set up for the new subject, technology. Objection was raised that this initiative had taken place without the inputs from the National Education Policy Initiative (NEPI) and the African National Congress (ANC) initiative. The new technology committee was chaired by the chief director of the Free State Education Department, Barend Wessels who worked on a core syllabus and guideline document for technology. The Natal Department of Education also set up a project where technology curriculum materials were being developed. As a result of pressure in the aforementioned committee, the Centre for Education Policy Development was approached.

Different views on how technology should be taken up in the curriculum persisted. CUMSA suggested that technology should be a separate subject, while the Centre for Education Policy Development advocated an integrated science-technology approach. After various discussions, Barend Wessels made a submission to the Heads of Education Department Committee (HEDCOM) regarding technology in the curriculum. HEDCOM decided in 1994 to trial the induction of technology as a school subject.

As a result, the National Project Committee (NPC), a stakeholder forum, was set up in 1995 to steer such a project. In April 1996, the NPC appointed the National Task Team (NTT) who actually became the driving force behind the project. By now the project was called "Technology 2005" or "T2005". The NTT was tasked to support, manage, co-ordinate and evaluate the process of curriculum development and implementation through Provincial Task Teams (PTT's). Their task also included the training of teachers. The timeline of this project was scheduled to last until March 1999. The NTT reported directly to HEDCOM and the Department of Education on a monthly basis (Kahn & Volmink, 1997, Reddy, 1998 and Technology 2005 Evaluation, 1998).

Running parallel to, but separate from Technology 2005, was the development of a new compulsory national curriculum for grade 1 to 9, which was to be called "Curriculum 2005". The section following will attempt to explain the relationship between Technology 2005 and Curriculum 2005.

1.3.2.3 The Technology 2005 project and Curriculum 2005

In March 1996, the Minister of Education launched Curriculum 2005. Without the submission of the Technology 2005 team, a national decision was taken that technology would be incorporated as one of the eight Learning Areas in the school curriculum. The new curriculum was to be phased in at grades 1 and 7 in 1998. Eventually it was only phased in at grade 1, which was a very wise decision considering the masses of in-service teachers who needed to be retrained for the new curriculum.

The new curriculum was more than a new curriculum – it introduced a new paradigm in education theory and practice. Curriculum 2005 is a departure from a content-based curriculum to an **outcomes-based curriculum** framework driven by a **vision of lifelong learning** for all South African learners. The outcomes-based paradigm, as well as the curriculum structures such as the National Qualifications Framework and South African Qualifications Authority, which will serve it, will be discussed expansively in Chapter 2.

The Technology 2005 project did not work out as planned, since it was taken up by Curriculum 2005. The new curriculum framework was designed around eight Learning Areas which are (Department of Education, 1997a:8):

- Language, literacy and communication
- Mathematical literacy, mathematics and mathematical sciences
- Human and social sciences
- Physical and natural sciences
- Arts and culture
- Economics and management science

- Life orientation

- Technology

In the *foundational phase* (grade 1-3) there will be only three Learning Areas, literacy, numeracy and life skills. Technology education will be incorporated into the life skills Learning Area. In the *intermediate phase* (grade 4-6) five Learning Areas will be introduced. They are language, literacy and communication; mathematical literacy, natural sciences and technology; human-social-management sciences and economics; art, culture and life orientation. Technology education will also be incorporated into the natural sciences -technology Learning Area. Only in the *senior phase* (grade 7-9) will all eight Learning Areas be implemented, where technology education will be a separate Learning Area.

For each of these Learning Areas a Learning Area Committee was set up to design frameworks and outcomes. The technology Learning Area Committee involved members from the Technology 2005 project. Finally, attempts to reconcile the agendas of Technology 2005 and Curriculum 2005, bore fruit and the Technology 2005 project was implemented in pilot schools in 1998. Evaluation, in the form of summative evaluation of this pilot project, needed to be undertaken. The Foundation for Research Development (FRD) funded the Technology 2005 National Implementation Evaluation Study. The objectives of this Evaluation Study were defined as follows (Technology 2005 Evaluation, 1999:11):

- To evaluate the implementation process of Technology 2005 (in terms of cost, feasibility, sustainability) and to establish how implementation procedures could be improved.

- To undertake a formative evaluation of selected aspects of Technology 2005 in order to provide feedback to role players such as the National Task Team, Provincial Task Teams and teachers in the sample schools.

- To establish benchmark data across a range of aspects in technology education.

- To develop a range of strategic options for policy-makers based on findings from the evaluation.

The author was a member of the Gauteng Evaluation Team and a co-writer of the final evaluation report, which was submitted on 17 December 1998 to the Centre for Science Development. All the data generated from this research are available to use in research by the author, as well as any other researchers who wish to continue this line of investigation. Where applicable, results from this research will be used to illustrate or validate certain knowledge claims made by the author. The most relevant results in terms of lessons that may be learnt from this local project will be presented in the next section.

Against this background of the development of technology education in South Africa, the discussion now turns to the role of the teacher and teacher training for technology education and specifically to problems associated with training of technology teachers.

1.3.2.4 Who will teach technology education in South Africa?

It cannot be denied that the successful implementation of any new curriculum relies heavily on the competency, commitment, dedication and sense of ownership of the teachers and principals acting as the change agents at school and classroom level. There are two aspects to this – retraining existing teachers and training new teachers who have to teach in a new system based on a new educational philosophy. The implications of a new outcomes-based curriculum, which represent a significant departure from a traditional curriculum, as well as a new Learning Area which has never officially been dealt with before in public South African schools, have far reaching consequences for pre- and in-service teacher training.

The educational innovations in South Africa imply a double mind shift to be made by future technology teachers and their educators. The first will be to conceptualise a new Learning Area with its theoretical and practice implications, as well as the outcomes-based approach from which teaching and learning have to take place. A mammoth teacher education and re-education task lies ahead.

Perhaps the same comment can be made as that by Kariyewasam (1996:223) about educational transformations in Sri-Lanka and the impact it had on preparing teachers for dealing with these transformation processes:

> *There appeared to be a lack of competent teachers to handle a programme of this nature...Their knowledge, skills and practices were so inadequate that it would have taken a quarter of a century to train them.*

This quotation is not meant to encourage pessimism, but to highlight how extensive the challenge in teacher education really is, especially training for technology education.

In the paragraphs which explored the implementation of technology education in different countries, it was often highlighted that the teacher's understanding of the nature of technology influences their teaching and assessment strategies and methodologies. The definition and nature of technology education, as it will be conceptualised and made appropriate for South African context will be explored in detail in Chapter 3.

(i) Experiences with the education of technology teachers

Many proposals and pilot programmes have been suggested for implementing technology education in various countries. The reality of proposals, as McCormick (1992:48) rightfully comments is "*what is contained in documents will only take effect when teachers share the understandings they contain. Implementing in schools is quite different from proposing".* It is the expert competent teachers who will have to make the vision, aims and outcomes of technology education reality. Various role players will have to cater for the education and training needs of the teachers in this relatively new field. In the Netherlands two streams of technology education are emerging. One is the general stream which will try to implement a new subject "technology education", while the other will continue with a "general techniques-vocational" approach. The result, De Vries (1992:38) notes, is that there is

> *... a lot of confusion among the teachers, most feel hardly competent to teach this new subject, either because they became eligible to teach it just because of their 'General Techniques' experience, or because they went through the*

extremely short and condensed retraining programme.

Barlex (1992: 24) and De Vries (1992:38) advise that *"more attention (should) be paid to conceptualization"* of technology education during in-service. It is however, the educational philosophy and understanding of the purpose and nature of a subject that will determine the practice endeavours. (Also see Section 3.5 for a detailed analysis of the nature and structure of technology and the appropriate methodology for facilitating learning in this Learning Area).

Though short and condensed programmes have their place and purpose in retraining teachers, more formalised and accredited forms of training teachers for technology education need to be considered. The State Board of Teacher Registration in Queensland, Australia for example, supports a model which was proposed for a formal four year Bachelor of Technology Education degree (Morgan & Wheeler, 1992:180-181). In South Africa, various teacher education colleges, technikons and universities are beginning to offer qualifications in the form of certificates, diplomas and degrees in technology education.

Teachers who have to teach technology in Curriculum 2005 did not obtain a formal qualification in this Learning Area. They received some form of in-service training, which varied form province to province. Although these initiatives were first attempts to retrain teachers for a new Learning Area, valuable lessons may be learnt from the local inputs.

(ii) *Lessons learnt from the Technology 2005 National Implementation Evaluation Study* (Technology 2005 Evaluation, 1998: 38-50)

The discussion to follow in this sub-section provides a situation analysis which highlights the needs in this new Learning Area. Discussions of the findings regarding the training of technology teachers, will naturally serve to sensitise the reader to the value and the possible contribution which this research can make to the generation of new knowledge in this field.

In 1998 as already mentioned, the National Research Foundation (NRF) funded a study, which had to evaluate the implementation of technology education in the pilot schools. The study was called the "Technology 2005 National Implementation Evaluation Study".

Only three of the provinces, namely Gauteng, Western Cape and KwaZulu Natal, where technology education was already offered for just under a year, were involved in the evaluation study. Part of the study was interested in the in-service training that the teachers received. In each school one or two teachers were designated to undergo the training. The teachers who were selected to attend the training were most likely those teachers who were to loose their jobs due to the fact that some subjects were to be integrated into the eight Learning Areas.

It is interesting to note that the teachers who were to teach technology used to teach or were currently teaching the following subjects (Technology 2005 Evaluation, 1998:25):

- Science (mathematics, science, biology and environmental science): 14,7 %.
- Technical subjects (needle work, wood work and technology): 10,7 %.
- Human sciences (languages, art, history and geography): 17,3%.
- Generalist (teachers teaching a variety of subjects or – in the primary schools teaching all subjects): 57,3 %.

In **Gauteng,** two teachers from each of the twenty pilot schools were trained by the non-governmental organisation called ORTSTEP. In Gauteng this form of training was a matter of project policy. Teachers attended the training on the occasional Saturday morning and during school holidays over a period of two years. The ORTSTEP training was mostly received positively and teachers reported that *"it helped a lot, and without the training I do not think that I will understand a thing"(* Technology 2005 Evaluation, 1998:38). The Technology 2005 Evaluation (1998:39) did, however find that the ORTSTEP training might not be entirely suitable for South Africa's need. One teacher did point out that it took a high-tech approach that could not be duplicated in many of the country's schools. Finally, many of the transformations relating to OBE and current curriculum issues were not covered by ORTSTEP. It must be noted however, that the ORTSTEP training started at a time when Curriculum 2005 and the outcomes-based approach were not yet official policy. Some of the feedback results from The Technology 2005 National Implementation Evaluation Study (1999:39) are the following:

- *More didactics of Technology, teaching and assessment need to be addressed during INSET.*

- *The training we have received (from ORTSTEP) in Technology will help you in a way to give Technology, but someone who did not do the training will still be able to cope in Technology.*

Another group which was responsible for the INSET in the provinces, were the Provincial Task Teams (PTT's). Each province had their own PTT. In Gauteng the PTT did not enjoy any official status from the provincial Education Department. Therefore no PTT training could be conducted during school times and had to take place in the teachers' own time and purely at the discretion of the teacher. Consequently attendance was sporadic. Teachers who attended the ORTSTEP training also had to attend the PTT training, where they were suppose to assist the PTT with the training where necessary. The comments below are made by teachers who attended both the ORTSTEP and PTT courses (Technology 2005 Evaluation, 1999:48):

> *The (PTT) training adds to my knowledge. Some of the things are a repeat of ORTSTEP, but for me I do not feel it is a repeat of the work, because if I go there I can listen again, because I did not have full training in that subject; we only had one day a week at ORTSTEP.*

A teacher who attended both ORTSTEP and PTT training compared the different methodologies which were used during their training and comments as follows (Technology 2005 Evaluation, 1999:48):

> *At ORTSTEP we were trained the OBE way and in the technological process. But at (the PTT) training we were taught a different way, which is fixed and not OBE.*

Teachers who only attended PTT training courses and no ORTSTEP training, made mixed comments (Technology 2005 Evaluation, 1999:49):

- *What I gained from the workshop is that they explain to us all the things we are going to work with. I was able to come up with some* *ideas of what to do in the class.*

- *No value at all! I need training to be able to work with more confidence. There is not enough time in a semester to be trained.*

Where a PTT conducted training sessions with the personnel of a whole school, teachers not directly involved in technology had a greater understanding of the integrative nature of technology and were more supportive of implementing technology. In school-based trained schools teachers from other Learning Areas collaborated with the new technology teachers to accommodate learning tasks which involved technological issues.

In **KwaZulu Natal** it appears that the PTT was very successful with their INSET work. Training consisted of six weeks during the year from May through December. Training consisted of intensive weekly sessions (Monday morning until Friday afternoon), after which teachers were asked for feedback and suggestions. Each school had to send at least one teacher, although some schools opted to send two. Apart from the training, teachers had regular back-up and support from the PTT who visited schools at least once a term between the training sessions. Good training materials also added value to the process. Comments regarding the training provided by the PTT were uniformly positive (Technology 2005 Evaluation, 1999:51):

- *Very valuable and I think it was a wonderful course. It opens up a whole new world of learning, and the Technology 2005 Task Team had really motivated us and explained all the jargon. They are doing it very well. This is my first experience with the subject.*

- *Very valuable, it makes you aware of the situation around you. I have more knowledge now and know that Technology is the centre of all Learning Areas.*

In **Western Cape**, INSET consisted of one week training before the start of the school year. Pilot schools were invited to send two teachers each. Follow-up workshops were delayed until mid-October due to administrative inefficiencies within the provincial Education Department. The PTT visited schools several times during the year to offer assistance to teachers. The value of the training elicited mixed results (Technology 2005

Evaluation, 1999:52):

- *Training was only a few days, It was a depressing week – teachers were treated as students. They spent four days on two projects, and my initial excitement about the project was dampened after that training.*

- *The Wellington thing was the best I have been to. I think that the main reason for that was that it was hands-on; we actually did the same things as children of the age.*

- *Well, as for training, I think we need a little more. The once-off week in the year isn't sufficient, you know.*

After the core group of teachers have been trained, each of the three provinces decided on a "cascading" or peer training model for the in-service training of their teachers. This model was said to have the potential for providing teachers with in-school back-up and support. The core group of teachers had to go back to their schools to train other teachers who were to teach technology (Technology 2005 Evaluation, 1998:6). Results finally showed that the cascading training model did not fully realise due to the following reasons (Technology 2005 Evaluation, 1998:6):

- The core group of teachers did not have time to train other teachers who also did not have time due to the fact that they had to teach other subjects as well.

- The core technology teacher could not use time in school or after school, because all the teachers were involved with sport and other extra mural activities. They did try however, to use the occasional off period for training during exam time.

- Not all the province's technology task teams gave substantial back-up and school support to enhance the sustainability of this new Learning Area.

For South Africa it can be concluded that technology education is included in Curriculum 2005 and it will have to be taught and learnt in an outcomes-based paradigm. This has the implication and imperative that teachers have to be trained accordingly.

1.4 Problem formulation and research questions

Teachers in South Africa are in the midst of all the educational transformation. Technology educators in particular have to implement a new Learning Area within the new Curriculum 2005 from an outcomes-based framework. With this new Learning Area, arrived the need for trained technology educators. Various in-service training programmes have been introduced with different degrees of success in the provinces. Overall, the in-service training that has been provided for retraining teachers, especially technology teachers has been inadequate. Furthermore, there are no definite signs that provincial education departments intend to put more effort and resources into in-service training, for various reasons. Therefore, the only long term hope of having adequately trained technology teachers lies in pre-service training.

The need is clear that a suitable model or approach of training technology teachers needs to be found, so that their competency may result in their learners maximising their potential in this field. Without the expert competent teacher, the vision and futuristic aims of technology education will not become reality.

The following problem formulation can serve as a general statement containing the conceptual underpinnings and focus of this research.

How should teachers be trained to become effective facilitators of learning in an outcomes-based technology curriculum?

The broad problem formulation will be broken down into research questions, which will provide foci for the research. The specific questions which will be addressed in this research, are the following:

1 What is the nature, extent and vision of educational transformation in South Africa?

2 What is the conceptual framework and implications of the outcomes-based

education paradigm for the professional training and development of teachers?

3 What is the substantive and syntactical structure of technology education?

These three questions are fundamental background issues that will be explored through the literature review.

The following questions will be researched through means of quantitative and qualitative research methods.

4 Is a problem-based learning model (PBL) a suitable, effective model to use in the training of pre-service technology teachers who have to facilitate learning within an OBE framework?

5 Will pre-service technology teachers be able to transfer their competencies obtained through a PBL training model to authentic classrooms to facilitate learning through PBL?

6 How will the PBL strategy used by the pre-service technology teachers impact on the learning quality and attitudes of learners?

1.5 Research methodology and design

The research methodology used for this research is not based on a single type of methodology. The different needs in this research are addressed through using different methodologies to answer the six research questions.

Creswell (1994: 177-178) describes a mixed methodology design where aspects of the quantitative and qualitative paradigms can be combined in the introduction, literature review, theory use, purpose statement and research questions. This approach adds complexity to a research design, but the main attraction of this design is that it uses the advantages of both the qualitative and quantitative paradigms. Obtaining data from a variety of resources through both quantitative and qualitative methods, will enhance the quality of knowledge claims made in this research. According to Leedy (1993:139) the decision on which methodology to use, depends on *"the nature of the data and the* *problem for research".* The nature of the research conducted in practice, following the literature research, manifests in two broad categories, namely quantitative and qualitative research.

To explain how these two methodologies were combined in this research, the information is presented in table format. The table describes the different resources which served as data points, the instrumentation used to gather the data, as well as a description of the **particular methodology** used to gather and analyse the data.

Resources: Data points	**Data gathering instruments**	**Type of methodology applied**
1 Grade 10 learners	1 Pre- and post- knowledge test written by the experimental and control group.	The data from the pre- and post-knowledge test, the attitude questionnaire and the LEMOSS questionnaire were quantitatively analysed by means of empirical-statistical methods.
• Experimental group • Control group	2 An attitude questionnaire completed only by the experimental group.	The comments by learners from the experimental group were **qualitatively** interpreted to enrich the empirical findings obtained from the attitude questionnaire.
	3 The learning and motivation strategies in science questionnaire (LEMOSS) completed by experimental group learners.	
	4 Brief written comments by learners from the experimental group to determine reasons for their attitude.	
2 Pre-service final year students	1 Written reports on their perceptions of technology and technology education prior to the PBL training. 2 Semi-structured individual interviews. 3 Log-books kept individually by each pre-service teacher of their practice implementation.	These instruments were **qualitatively** administered. 1 The written reports were analysed. 2 The interviews were transcribed and analysed. 3 Written texts in the log-books were analysed.

The details of the resources and instruments presented in the table will be elaborated in Chapter 4. The purpose of this table is merely to give an overview of how the quantitative and qualitative methodologies were combined in this research design.

1.6 Significance of this research

The previous parts of this chapter have already highlighted some of the shortcomings which might be addressed through research of this kind. Firstly, the entire field of education and training in South Africa is in various stages of reform, based on the paradigm of outcomes-based education. This is a radical departure from content-based curricula and the transmission model of teaching and learning. To retrain teachers to understand the philosophy, practice and systems of a new approach to education is a challenging endeavour which needs to be engaged in. Secondly, attempts have been launched to prepare in-service teachers for a double duty: one for practising a new outcomes-based approach and the other for implementing a new Learning Area, technology education. The in-service efforts were noble, but did not have the impact and sustainable results ideally envisaged. As a long-term solution, this research accepted the challenge of trying to find answers and to test findings on how to train pre-service teachers for their new and important task.

After an extensive literature research, a meta-curriculum model was designed which was used as the basis of a pre-service training programme for science teachers who were trained to facilitate technology as well. This model explores a problem-based learning approach for two reasons. Firstly, because problem-based learning is an overarching strategy which has potential to operationalise outcomes-based practice. Secondly, the problem-based learning strategy is coherent with the innate nature and structure of technology education. The model was therefore named the OBE-PBL model. This model served as the pre-service training model. The model was implemented in the same way that pre-service technology teachers are expected to teach in authentic school contexts once they have left the university classrooms. The "what" and "how to" of their course was **modelled** to the pre-service teachers. In other words, the training programme did not use a transmission-lecturing approach to develop their technology education and professional competencies. This particular section of the research may contribute towards the search for effective teaching and learning strategies which may be used within the OBE framework, and in particular in technology education. In both of the new initiatives and especially in relation to one another, knowledge and guidelines for practice in terms of curriculum, classroom implementation and assessment, are needed. This research hopes to fulfil some of the needs of the practising cadre of teachers who have to "make it happen" at classroom level.

A significant contribution of this research is the fact that it went beyond the design and implementation of the OBE-PBL model for pre-service teachers only. This research made a **direct link** between the pre-service training and the classroom practice. Often when trainees exchange classrooms for their real world work place, they cannot transfer and sustain their newly gained competencies. If any pre- or in-service teacher cannot successfully transfer their competencies to real classrooms and act as change agents in their schools, then the training was a sterile, expensive and worthless exercise. The PBL strategy is investigated as the key factor contributing to bridging the gap between knowledge acquisition and application when and where it matters. The fact that pre-service teacher training success is tested in real classrooms, contributes to complexity, but also to the uniqueness of this research. Feedback from both the pre-service teacher level and the learner classroom level, is used to refine the OBE-PBL model and the implementation thereof for future training inputs which might help the pre-service teachers to make an effective transition from university to workplace.

In summary, this research will contribute towards both theory in terms of scientific knowledge and especially the practice of training pre-service teachers to facilitate technology education from an outcomes-based paradigm and to do that effectively and successfully in their real work place, the school.

1.7 Overview of the study

The first chapter orientates the reader by identifying and formulating the **problem** to be addressed by this research. The rationale and brief history of technology education internationally as well as nationally are presented. It is against this background that the problem is explored in depth and this makes it possible to formulate research questions to be answered.

The introduction of technology education in South African curricula, is one of the many educational transformation initiatives. To comprehend the implications of technology education in curricula, it is of vital importance to have a holistic view of the education transformation process, and transformation in South Africa in general. Since the transformation intended in education is more than cosmetic transformation, the underlying paradigm and vision will be explored in chapter two. The implications and imperatives of **outcomes-based education** on curriculum structures, curriculum design, educational theory and practice are contextualised.

The third chapter presents a conceptual framework of what technology education is and what it is not. Once the terrain of **technology education** is clarified, the nature and structure of this new Learning Area will be highlighted, since it has far reaching implications for the training of teachers who are to facilitate technology education. Another purpose of this chapter is to explore the possibilities of a problem-based learning model (PBL) as an appropriate model for pre-service technology teacher training from an outcomes-based perspective. The foundations addressed in chapters two and three will culminate in the design of a meta-model, called the OBE-PBL model, which will be implemented and evaluated on two levels. Level one will entail the training for the pre-service technology educators based on the OBE-PBL model and, on the next level, the pre-service teachers will implement the model in authentic classroom contexts.

The **research design** and **methodologies** are discussed expansively in chapter four. The six month problem-based training programme that was used to build the capacity of the pre-service teachers to become facilitators of technology education, is discussed. Training in isolation without giving the pre-service teachers the opportunity to implement their competencies in real life practical situation, is sterile and abstract. Therefore, a report is also given of their one month experience in the classrooms as facilitators of technology education. The interventions with both the experimental and control groups are also discussed in this chapter.

In chapter five, the OBE-PBL model used for the training of technology teachers is investigated by quantitative and qualitative methods. Data will be gathered from two data sources, namely the pre-service teachers themselves and the learners with whom they have intervened. The results obtained from different resources are presented, analysed, interpreted, and conclusions are drawn with the different research questions to be answered in mind.

The final chapter, chapter six, reflects holistically on the research and the research questions asked. Conclusions are drawn about the effectiveness of the OBE-PBL training model and recommendations are made for future research.