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**An investigation of the development of
students' and teachers' perceptions towards
technology: A framework for reconstructing
technology education in Malawi**

*A thesis submitted in fulfilment
of the requirements for the degree of*

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Abstract

The study investigated students' and teachers' perceptions towards technology and technology education with the ultimate aim of developing their beliefs and practices suitable for teaching and learning broad-based technology education and to inform future policy framework for restructuring the curriculum. Research leading to the development of technology as a school curriculum shows emphasis on the importance of students developing technological literacy essential for living in a technologically mediated society but little is known about developments related to teaching and learning technology in Malawi schools. Malawi's Vision 2020, the Science and Technology Policy for Malawi and the Malawi Growth and Development Strategy 2006 – 2011 stipulated the need for schooling in Malawi to help students attain technological literacy as it was seen as instrumental for economic growth and development. Attempts were undertaken to include science and technology and also craft, design and technology as learning areas, but among a myriad of factors, teachers lacked theoretical, philosophical and pedagogical underpinnings of the subjects. The existing curriculum also has little scope for developing student technological knowledge and capabilities which would enable them to understand, create, control and manipulate technology. The need now is to establish technology education as a more comprehensive curriculum area than that promulgated in the technical curriculum. This study therefore provided teachers with an opportunity to broaden their understanding of the nature of technology and technology education critical for their meaningful conceptualisation of teaching and learning technology.

The focus of the study was to explore influences of, expand the teachers' and students' ideas about technology and technology education and also to enhance teaching practices. In order to capture a more holistic understanding of such influences, an interpretive research methodology was adopted and the teachers were involved in in-depth, one-on-one and semi-structured interviews, group discussions and classroom observations before and after professional development workshops. This helped to collectively construct the social reality surrounding the teachers' existing beliefs and teaching practices and how to change those practices and beliefs. The study was situated in a socio-cultural

theoretical framework by encouraging collaborative interactions among teachers in their school groups.

The study began by examining students' and teachers' existing beliefs and practices and these were seen as impacting on how and what teachers learn. A teacher professional development programme incorporating those beliefs and practices and also focusing on social-cultural frameworks of learning was organised to help teachers reconceptualise their understanding about the nature of technology and technology education. The professional development programme also incorporated a discussion of PATT modelling as a tool for teacher learning of students' conceptualisation of technology and reflections of their own learning in the workshops. Key characteristics of the professional development model, therefore, included:

- An understanding and incorporating the teachers' beliefs and practices into the professional development programme for teachers to change such beliefs and adopt broader views of technology.
- Encouraging collaborative learning in their schools for teachers to share knowledge, their own experiences and that of others, and planning presentations of their interpretations of selected scholarly readings.
- Teachers learning about technology from the perspectives of students using PATT data that was seen as an effective professional development tool.
- On-going reflections and support to enhance teachers' capacities to reflect on their own experiences for purposeful change.

The professional development helped teachers develop a broader understanding of the nature of technology and technology education using a model that focussed on teachers developing their own concepts through readings of scholarly papers, learning from other teachers' experiences and through discussion of student concepts and attitudes to technology. Findings of the research revealed an effective professional development model focussed on social cultural frameworks of learning that resulted in teachers' positive

perceptions of technology and technology education. They had also shown innovations to implement technology as a consequence of their enhanced technological pedagogical knowledge. Three key findings arose from the study, and these are:

- The teachers' contexts and the stance on the goals of the technical education curriculum influence understanding of the nature of technology and technology education.
- Enhanced technological pedagogical knowledge promotes teachers' innovations to develop and implement technological activities.
- A professional development underpinned by social cultural frameworks of learning is an effective model when it incorporates teachers' beliefs and experiences.

The findings of the study have implications for pre-service and in-service teacher education and development, policy change in relation to curriculum reviews and reforms in Malawi and other developing countries. There are also implications for further research that focus on developing knowledge and understanding among teachers on how to improve teaching and learning that enhances student technological literacy but which considers the context being targeted by the curriculum. Enabling policy for implementing technology education in Malawi exists but a successful realisation of the policy goals is entirely dependent on teachers' shared understanding about the nature of technology and technology education. This study provided teachers with a rare opportunity for further professional growth and development leading to improved teaching practices and knowledge about technology and technology education. Therefore, more research of this nature would be required to help develop capacity for reconstructing technology education in Malawi and other developing nations which may also plan to shift from colonial industrial arts-based curriculum to a broad-based technology education.

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Acronyms

CDT	Craft Design and Technology
DEPTH	Developing Professional Thinking for Technology Teachers
FPE	Free Primary Education
HDI	Human Development Index
IDA	International Development Agency
MDG	Millennium Development Goals
MGDS	Malawi Growth and Development Strategy
MPRSP	Malawi Poverty Reduction Strategy Paper
PATT	Students' Attitude towards Technology
PBL	Problem-based learning
PCK	Pedagogical Content Knowledge
PD	Professional Development
PIF	Policy and Investment Framework
R&D	Research and Development
RSA	Republic of South Africa
S&T	Science and Technology
SPSS	Statistical Package for Social Scientists
UK	United Kingdom
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USA	United States of America
WBL	Work-based learning

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Research leading to the development of technology as a school curriculum in many countries shows an emphasis on the importance of students developing technological literacy essential for living in a technologically mediated society (de Vries, 2006; Jones, 2009; Rasinen, 2003). As Malawi is also part of a global village, students need empowerment through knowledge and capabilities to be able to live in a world increasingly becoming technological. However, little is known about developments related to teaching and learning technology in Malawi schools. As a British colony, Malawi adopted the UK system of education including assessment practices, but the curriculum was expected to be functional in terms of relevance and responsiveness to the requirements of school leavers' lives in a rural economy. The comprehensive, post-independence national education development plan 1973-1980 and a follow up educational development plan 1985-1995, reinforced policies in favour of the vocationalisation of the school curriculum as this was seen as an option to help address manpower training needs for industrial growth, while also providing the youth with skills for self and small-scale business employment. For about five decades since independence, Malawi offers the same industrial arts-based curriculum but, suffice to say, poverty and youth unemployment have continued to escalate despite the promises and expectations of such a curriculum. Sustainability of the programme has also been a major hurdle as huge capital requirements make the programme expensive and this was compounded by policy changes by funding agencies (Bennell, 1996; Psacharopoulos, 1987). The program is also selectively offered to a small number of students in 13 pilot schools where learning facilities were provided, but currently these are almost obsolete. There was hardly any expansion of the programme to reach out to many students for any meaningful impact on poverty reduction. This study therefore, pioneers into research in Malawi to explore and develop an understanding of alternative practices, knowledge and concepts for a curriculum that fosters technological literacy for all students. The study focuses on understanding students' perceptions of technology and technology education

and enhancing teachers' technological and pedagogical knowledge and practices. Ultimately, the study helps to inform policy framework for restructuring the technical curriculum and to establish broad-based technology education as a learning area. The study also helps establish a foundation for further research to inform development of knowledge and technological and pedagogical practices.

1.2 Rationale of the study

Over the past two decades, many countries have reformed their school curricula to establish technology as a learning area (de Vries, 2006; Lewis, 2000). However, research (for example, Dakers, 2006; Dugger Jr., 2006; Jones, 2003; Lewis, 2000; Sade & Coll, 2003) shows that most countries that have adopted technology education are from the western bloc of the world economy where technological developments are advanced. In the West, the rationale for technology education was epitomised by economic, social and educational assumptions, but their technological advancement also influenced the nature of their technology education (Lewis, 2000). Many other countries, particularly those categorised as least developed countries, have maintained their imperial curriculum, as they have, over the past two decades, been preoccupied with democratisation, poverty alleviation and other socio-economic problems (Kerre, 1994). Kerre attributed the state of technology education in least developed countries to political instability, resource constraints and lack of scholars with a shared understanding of technology. Among the sub-Saharan African countries, the Republic of South Africa (RSA) and Botswana have incorporated technology education and design and technology respectively as learning areas in their curricula (Stevens, 2006; Weeks, 2005). Botswana and RSA are classified by the World Bank (2007) as upper middle income economies with gross national income per capita between US\$3,706 and US\$11,455 which is much higher than other countries within the region. The two sub-Saharan nations are hence economic giants with a huge and more developed capacity for investment in education compared to other countries within the Southern African region and their position as such does influence knowledge and policy developments.

Malawi, like many African countries, currently offers the technical subjects of metalwork, woodwork and technical drawing with teaching emphasizing a narrow

craft skills approach. Malawi was a British colony until 1964 when it attained political independence, and education was modelled on the British system. Despite overarching education reforms in England (Banks & McCormick, 2006), Malawi has maintained the traditional system with few subject changes. In particular, the craft and skills-based technical subjects in the general education curriculum have largely remained the same.

Malawi is a poor country and lags behind technologically (Ministry of Economic Planning and Development, 2004). The *Malawi Poverty Reduction Strategy Paper* (MPRSP) (Ministry of Finance, 2002) recognises that: “The low content of science and technology in national economic development programmes is a barrier to economic growth leading to high levels of poverty among Malawians” (p. 92). As the economy is agro-based, the *Malawi Economic Growth Strategy* (Ministry of Economic Planning and Development, 2004) focuses on reducing poverty through increased access to basic social services, accelerating growth and improving productivity in agriculture and the manufacturing sectors. The role of technology education is shown to be critical in enhancing the technological capabilities of citizens for their participation in the country’s economic activities. The government’s economic development agenda is to transform Malawi from an importing and consuming country to a producing and exporting nation. However, despite undertaking a number of national curriculum reforms (Nyirenda, 2005), technical subjects in Malawi have not been reviewed to articulate emerging issues, government policies and development agendas. For instance, Malawi’s vision statement aims for a technologically driven economy. According to Vision 2020 (National Economic Council, 2003):

Malawians aspire to have a science and technology-driven economy. This will be characterized by improved science and technology education, training and culture; increased commercialization of research and development (R&D); adaptation and promotion of new and emerging technologies; promotion of environmentally-sound technologies; existence of effective science and technology (S&T); and increased implementation and use of information technology (Achieving science and technology-led development, para. 1).

Vision 2020 therefore recommended a review of the school curriculum, the promotion of skills training and the development and introduction of a culture of science and technology. The suggested curriculum reforms focus on national educational programmes that are more reflective of the changing socio-economic and political realities. The strategic options for attaining the vision included strengthening science and technology education through the teaching of science in primary and secondary schools, and also strengthening the teaching of computer studies and technical subjects. As a consequence, the Malawi Poverty Reduction Strategy, a medium-term focussed action plan, followed by the Malawi Growth and Development Strategy (Ministry of Finance, 2002, 2006), stipulated an intensified application of science and technology to be facilitated by the creation of a science and technology culture to encourage its appreciation by the Malawian society and also for a science and technology-led development. The Science and Technology Policy for Malawi also included a strategy to enhance technological literacy through curriculum changes (National Research Council of Malawi, 2002).

However, five decades later, the curriculum remains much the same. In its current form, the curriculum provides little scope for developing student capabilities so they can understand, create, control and manipulate technology. In order to address the policy strategies for technological literacy, computer studies and science and technology were introduced in 2001 as learning areas (Fabiano, 2002; Ministry of Education and Vocational Training, 2001b, 2001c), but curriculum strategies seemed similar to the assumptions guiding curriculum vocationalisation, which focussed on craft and artisan skills development for employment. Science and technology was also established as a core learning area to provide learners with an understanding of the close relationship between scientific knowledge and technological applications (Fabiano, 2002). The strategies for addressing a technology culture as outlined in Vision 2020 (National Economic Council, 2003) appeared to have been interpreted in the same manner as the assumptions of a vocationalised curriculum. For instance the goal for computer studies appeared to focus on realigning learners with computer related jobs. The introduction of the new subjects therefore, seemed to be an attempt to de-establish technical subjects when policy guidelines still demanded an enhancement of technological literacy.

Technological literacy in Malawi is still a central part of the government's envisioned plans for technology-led development and this suggests a shift to a new curriculum model for student learning. Such a curriculum may need to empower students to think and reason through problem-solving, leading to students acquiring capabilities necessary for self-reliance and confidence for effective participation in social and economic development. While the current situation of poverty, small industrial base, and a predominantly rural economy may appear to be a hindrance to effective learning of technology, the same conditions may also be viewed as providing rich opportunities and contexts for students' meaningful learning, as the students may be challenged with authentic problems affecting the communities in which they live. However, implementation of such ideas is a daunting task and requires a shift of attitudes and practices at policy as well as classroom level. So it seems necessary to get a better understanding of what it means to teach technology and identify pedagogies in support of students' technological capabilities. To do so, it is pivotal to learn about teachers' existing views and practices from which broader notions of technology education may be developed.

As a means of attaining relevance to the curriculum, the Policy and Investment Framework (PIF) (Ministry of Education and Vocational Training, 2001a) stipulated that:

...the primary and secondary school curriculum of the future should strive to impart essential skills and knowledge on a broad range of issues including new basic skills: critical thinking and analytical skills, civic and democratic values, computer skills, entrepreneurial skills, life skills and environmental education (p.12).

As a consequence, the MPRSP stipulated an intensified application of science and technology to be facilitated by the creation of a science and technology culture in order to encourage appreciation of S&T in Malawian society. The S&T policy for Malawi also included, as a strategy, the upgrading of the science and technology curriculum to enhance technological literacy (National Research Council of Malawi, 2002). In response to these policy guidelines, new syllabi were developed in 2000 (Fabiano, 2002; Ministry of Education and Vocational Training, 2001c).

These incorporated Science and Technology into the school curriculum as an integrated core learning area, replacing Physics and General Science. After a protracted debate with the University, Physics and General Science subjects were re-introduced and became core subjects again as they are prerequisites for entry to most university programmes. During the development of the new syllabi, technical subjects were not reviewed and have continued to be offered independent from, and alongside, Science and Technology. It was therefore evident that the technical education curriculum was side-lined in the implementation of policy strategies. This was despite its prominence in, and centrality for, harnessing Malawi's technological development potential and poverty alleviation initiatives (Ministry of Economic Planning and Development, 2004; Ministry of Finance, 2002; National Research Council of Malawi, 2002). For instance, among several strategies for improving prospects for economic growth, the introduction of vocational, technical and business management courses at primary and secondary schools were recommended as strategies for addressing weaknesses in the human resource base (Ministry of Economic Planning and Development, 2004). The technical education curriculum therefore needs review so as to offer students broad-based technology education. Students' experience in technology education helps in enhancing their capabilities to be able to fully participate in society initiatives for a technologically driven economy (Jones, 2003; Lewis, 2000; Petrina, 2000; Technology for All Americans Project, 2000). The *Malawi Growth and Development Strategy* (MGDS) included reviewing and reforming school curricula to address national needs as a key strategy for enhancing the quality and relevance of education. This study will therefore inform efforts towards the review of the subject for an alternative teaching and learning which should enhance students' technological literacy in line with government's development agenda as stipulated in its major policies (Ministry of Economic Planning and Development, 2004; Ministry of Finance, 2002; National Economic Council, 2003; National Research Council of Malawi, 2002).

1.2 Context of the study

Malawi is a landlocked country situated in Southern Africa and shares borders with Tanzania to the north east, Zambia to the west and north-west, and

Mozambique to the south, south east and south west. Malawi's land area is approximately 118,500 square kilometres of which 20% is occupied by Lake Malawi, Africa's third largest freshwater lake (World Bank, 2005b). In the 2008 census, the population of Malawi was estimated at 13.1 million, of which about 52% is under the age of 18 (National Statistical Office of Malawi, 2008). Malawi therefore, has a young population that needs sound education programmes if its society is to achieve technological literacy and leapfrog from the poverty cocoon.

Malawi is the 13th poorest country in the world, with a Human Development Index (HDI) of 0.437, which ranks the country at 164th out of 177 countries (United Nations Development Programme, 2005). HDI is a composite of indicators of life expectancy, educational attainment and income established by the United Nations Development Programme (UNDP) as a way of measuring national development. The country's income *per capita* was pegged at US\$200 in 2001 compared to US\$460 in the Southern African sub-region (World Bank, 2005a). According to an Integrated Household Survey 2004/05 and the 2006 Millennium Development Goals (MDG) Malawi report, the current status of poverty estimates shows that 52.4% of the population lives below the poverty line with 22% in ultra-poverty (Ministry of Economic Planning and Development, 2005; Ministry of Finance, 2006). Malawi's poverty is attributed to limited access to land, low education, poor health status, limited off-farm employment, low technological developments and lack of access to credit which has resulted from poor social, human capital and economic indicators (Ministry of Economic Planning and Development, 2004; Ministry of Finance, 2002). A curriculum that incorporates technology may therefore help foster the country's socio-economic development - as even a rudimentary understanding of technology enables one to evaluate, select and make more effective use of technological products and services (Faure et al., 1972).

Malawi's economy is dependent on rain fed agriculture and tobacco, with sugar and coffee accounting for 60% of Malawi's export earnings. The Malawi Government has of late emphasized diversification of the economic base through manufacturing and adding value to agriculture products (Ministry of Finance, 2002). As the current drive is for a Science and Technology (S&T) led economy, technology as a school subject would therefore be ideal to popularise societal

technology and dispose populaces towards its acceptance and creation (Lewis, 2000; Ministry of Finance, 2002; National Research Council of Malawi, 2002). About 90% of Malawi's population lives in rural areas and more often rely upon indigenous techniques (Ministry of Finance, 2002). Technology education may therefore bring new life perspectives towards rural development which is an agenda of most governments in third world countries (World Bank, 2005a). Lewis (2000) argued that the need for technology education is more compelling in the third world than it is in the more developed world and it must be part of everyone's basic education.

The structure of education in Malawi is based on an 8+4+4 system: that is 8 years of primary school, 4 years secondary and 4 plus years of tertiary education. In 1994, Malawi introduced free primary education (FPE) in order to meet targets of Education for All and providing universal primary education, which is one of the targets of the Millennium Development Goals (Ministry of Economic Planning and Development, 2005; Ministry of Education and Vocational Training, 2001a; World Bank, 2004). It is also indicated in the PIF that universal primary education gives the highest social returns to investment – a more economically active, informed, healthier and participatory population (Ministry of Education and Vocational Training, 2001a). Integrating programmes that promote technological literacy of citizens may help empower them with capabilities necessary for their meaningful contribution to such goals. FPE would also help Malawi increase the population literacy rate which was estimated at 64% (75.8% male and 52.4% female) during the 2004-2005 Integrated Household Survey and currently rated at 73% by UNICEF in the 2005-2008 period (National Statistical Office of Malawi, 2005; United Nations International Children's Emergency Fund (UNICEF), 2011).

The PIF (Ministry of Education and Vocational Training, 2001a) showed that with FPE, enrolment rose from two million in the 1993/1994 academic year to three million in the 1994/1995 academic year and to about 3.1 million in 2001. The introduction of FPE also increased the student/teacher ratio, student/classroom ratio which were estimated at 84:1 and 107:1 (Ministry of Education and Vocational Training, 2006). FPE also increased competition for places in secondary schools and tertiary colleges and the drop-out rate also increased significantly. According to the World Bank (2004), about 60% drop out at the end

of standard 8 (Year 8), with only 4% proceeding to university after secondary school.

Vision 2020, PIF, the MPRSP, Millennium Development Goals and the National Science and Technology Policy (Ministry of Economic Planning and Development, 2005; National Economic Council, 2003; National Research Council of Malawi, 2002) are major policy guidelines for Malawi. They all put education to the fore towards developing science and technology and eradicating poverty. However, the current curriculum does not provide students with skills to become economically active. Therefore those that drop out have difficulty getting jobs or self-employment, let alone understanding the technological developments taking place, or that need to be undertaken, at the personal, community or national level. Hence, there is a need to review the technical curriculum so that there are opportunities to provide an alternative education that can impart knowledge, capabilities and skills responsive to the social, economic, and environmental climate of Malawi. An understanding of the students' and teachers' perception of technology is therefore a first step towards informing the process of reconstructing the curriculum.

1.3 Statement of Research

Soon after gaining political independence from Britain in 1964, Malawi, with funding from the International Development Agency (IDA), introduced technical subjects in 13 secondary schools (Cartwright, 1988). The aim was to attract students towards engineering related study and to provide them with skills for jobs and self-employment. These assumptions were based on the premise that a comprehensive curriculum would help in adaptation and increase social and occupational mobility while others viewed it as a programme which promotes social exclusion (Arum & Shavit, 1995; Msiska, 1994; Urevbu, 1988). The school curriculum was vocationalised amidst debate on the benefits of such a curriculum and on the role of schools, though seen as clumsy instruments in inducing rapid and large-scale social change (Foster, 1977; Godwin, 1990; King & Martin, 2002; Sanderson, 1993; Watson, 1994). Opponents of a vocational curriculum argued that such a curriculum inhibits further study and thus reduces future socio-economic attainment. Proponents of a vocational curriculum, on the other hand,

argued that it helps students skip unemployment and increases their chances of becoming skilled workers (Arum & Shavit, 1995). Godwin (1990) also pointed out that many countries in Africa hoped that diversification of the curriculum would contribute towards easing unemployment problems, and significantly assist in promoting enhanced levels of economic growth and productivity.

Debate that ensued about the goals and assumptions of a curriculum of this nature (Lauglo, 2005; Oketch, 2007) leading onto evaluation studies on the efficacy of the vocationalisation of the secondary school curriculum had shown that technical subjects were twice as expensive as academic subjects and that graduate social rates of return were lower (Psacharopoulos, 1987). However, Bennell (1996) argued that no evidence existed to support the traditional stance that the social rates of return were lower for vocationalised secondary education than general secondary education as the evaluations were viewed to have been based on ineffective provisions of practical subjects. However, others (King & Martin, 2002; Msiska, 1994) argued that the philosophy of vocationalisation as a ploy for mitigating the social, political and economic problems persistent in the third world countries was fallacious and unattainable and suggested that it should be offered outside general education and be employment-based.

It was also argued by Lauglo (2005), that the implementation of a vocationalised curriculum was impacted upon by general and logistical constraints as well as constraints on economic relevance, personal development goals and social-political goals. Despite these constraints, it seems there is still sustained interest in the diversified curriculum as it was also seen as a safety net, reducing the probability of unemployment in the lowest paying jobs (Shavit & Müller, 2000; Sifuna, 1992). Consequently many developing countries in Africa and elsewhere have maintained the vocationalisation policies (Oketch, 2007). The policies were still driven by the traditional assumptions (Oketch, 2007) such as a cure for youth unemployment; adaptation for further study in engineering; knowledge and skills for an industrial revolution as in Japan, Germany and the United Kingdom; and also as a tool for poverty alleviation. The need for a vocationalised curriculum was therefore compounded by poverty and youth unemployment but these have continued to escalate despite the existence of a curriculum specifically developed to address such issues. Industrial growth has also continued to stagnate and

unparalleled low uptake of students from such schools in tertiary engineering programmes is evident.

Persistent poverty and youth unemployment in Malawi and many third world countries put into question the merits of a comprehensive curriculum and the complementary nature of general and vocational education. The curriculum has not functioned as intended by the planners which seems to show over reliance on the 13 pilot schools in Malawi to provide the much needed skills for jobs and entrepreneurship and also to attract capable students to study engineering for industrial growth and development. Further, the curriculum failed to provide creativity, resourcefulness and innovativeness in the areas of science and technology, which it was charged to do. Hence, there is a great need to investigate other curriculum approaches which may help develop students' capabilities to think, solve problems and appreciate technological developments. A more general curriculum targeting students' technological literacy appears to be a better option and hence the need to understand existing traditions and practices.

Research related to students' and teachers' perceptions of technology has been a major feature of curriculum reforms and has shown that students' and teachers' perceptions have an effect on their understandings and practices in technology education (Burns, 1992; Jones & Carr, 1993b). This study therefore investigated the perceptions of students and teachers in Malawi towards technology. The impact of technology on the current and future lives of society's youth makes it especially important to understand technology and teaching practices from the students' perspective (Frantom, Green, & Hoffman, 2002). The study investigated existing teaching practices from which a teacher professional development programme was developed. As in Compton & Jones (1998), the professional development was expected to transform teachers' perceptions and enhance their understanding of technology and technology education. As traditional teaching of technical subjects over emphasises craft based skills, a paradigm shift in terms of pedagogy that embraces socio-cultural perspectives of learning, may help enhance teaching and learning in the subject (Dow, 2006b; McCormick, 2004; Wenger, 1999). Drawing teachers' attention to authentic and meaningful learning experiences situated in their local environment could not only help cultivate the

students' enthusiasm but also allow them to begin to appreciate their role in technological developments affecting their communities.

1.4 Study Objectives

The aim of this study was to investigate the development of students' and teachers' perceptions towards technology leading to a framework that may help in restructuring the technology curriculum in Malawi. The study involved examining secondary schools students' perceptions and attitudes towards technology and their learning in technology education. The study also investigated teachers' existing practices and their perceptions towards technology and technology education and how such perceptions may be transformed to enhance teaching and learning in secondary school technology. Three specific objectives arose. They were:

- To explore views of students towards technology.
- To explore views of teachers towards technology and technology education.
- To enhance teachers' pedagogical and content knowledge in technology.

1.5 Significance of the Study

In Malawi, technical education emphasises craft and skills development and the curriculum has largely remained the same, despite undertaking a number of national policy and curriculum reforms for learning that fosters technological literacy (National Research Council of Malawi, 2002; Nyirenda, 2005). The technical education curriculum has maintained its industrial arts UK origins for five decades and therefore remains colonial and restricted to skills training with little consideration of the Malawian context and prevailing social and economic conditions. Hence, a shift from a colonial-based technical curriculum to a broad-based technology education incorporating local context requires a concerted effort drawn from across the social divide – with the teachers' role in such efforts being central to the design and development process of a new learning area. Technical education is a technology related subject and all along teaching and learning have only concentrated on motor skills development, while intellectual skills and

conceptual dimensions of what technology encompasses were less emphasised. Technical teachers have therefore developed experiences and beliefs in their assumptions of such a curriculum. Engaging with teachers may help to understand their implicit beliefs and theories surrounding their teaching practices and how that impacts on curriculum reforms. A lack of understanding and mechanisms for deconstructing such beliefs may result in teachers implementing the 'old tricks' leading to the same old subject being delivered only with a new name.

All major policy guidelines for Malawi (Ministry of Economic Planning and Development, 2004, 2005; Ministry of Education and Vocational Training, 2001a; Ministry of Finance, 2002; National Research Council of Malawi, 2002) put education to the fore as a conduit for developing science and technology and eradicating poverty. However, the current technical education curriculum has not provided school students with sufficient skills and knowledge for them to become economically active. Those that drop out face barriers in finding employment. Also, they have difficulties understanding current technological developments at the personal, community and national levels. Hence, there is a need to review and change the current technical education curriculum so that it promotes opportunities in schools to build students' knowledge, capabilities and skills to be more responsive to the social, economic, and environmental climate of Malawi. Malawi needs a curriculum that promotes social, economic and environmental awareness and development - and at the same time enhances beliefs and values of the society. An understanding of the students' and teachers' perceptions towards technology and the trialling of a teacher professional development programme are therefore primary steps towards informing the process of reconstructing the technical curriculum to incorporate broader notions of technology education. This study is therefore significant as it is expected to enhance the teachers' perceptions and hence improve the teachers' technological and pedagogical knowledge for effective teaching and learning in technology. The study will also help provide an understanding of how school curricula in the third world countries can begin to establish technology as a learning area within constraints of resources, low technological developments, escalating poverty, and ever increasing population growth. The study will therefore contribute knowledge and understanding of technology from a third world perspective and how technology education

frameworks from developed nations influence curriculum reforms in such impoverished nations.

1.6 Overview of the thesis

Chapter One outlines the foundation or rationale of the study, context, statement of the problem and significance of the study. It has been shown that while Malawi is poor and lags technologically, technology education would empower the students' democratic potential to participate meaningfully in developments that impact on their life and that of their society. The study specifically pioneers technology-related research in Malawi and focuses on enhancing teachers' technological knowledge and practices and how that impacts on reforms for restructuring the technical education curriculum to adopt a more generic and broad-based technology education. Chapter Two reviews literature related to technology and technology education. It specifically discusses previous research on teachers and students perceptions, the transition from traditional technical subjects to technology education, professional development and the theoretical framework adopted for the study. Chapter Three outlines the research methodology. Chapters Four, Five and Six report on the results and findings of the study. Chapter Seven outlines the discussion of the findings and presents a conclusion and implications for teacher development and training, curriculum and educational policy review and implications for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Perceptions of technology and the conceptions of the nature and scope of technology and technology education have characterised research for establishing technology curricula around the world (Jones, 2003; Mawson, 2003). Recent research focuses on developing technological capabilities, enhancing classroom practices and promoting learning that emphasizes social views (for example, Lewis, 1999; McCormick, 2004; Pavlova, 2005; Stevenson, 2004; Zuga, 2004). As this study aims to develop perceptions to enhance understanding of technology, this section reviews literature related to students' and teachers' perceptions towards technology and technology education. There will also be a review of studies on teacher professional development and how these have informed curriculum development in various countries. An overview of the transition from technical education to technology education is also discussed. The review synthesises social views of learning in technology and how these could inform the situation in Malawi. A socio-cultural theoretical framework that underpins the study is presented.

2.2 The Transition from Technical Education to Technology Education

In the early 1990s, many countries, especially those from the Western bloc, implemented curriculum reforms to incorporate technology education, a shift from the traditional technical subjects or industrial arts (e.g. Jones, 2003; Kerre, 1994; Lewis, 2000; McCormick, 1993a; Satchwell & Dugger Jr, 1996). The New Zealand Curriculum Framework of 1993 incorporated technology as a standalone subject and an essential learning area following the curriculum reforms that took place in 1990 (Jones, 2003). The justification for the reforms in New Zealand focussed on the beliefs that students should be empowered with capabilities to enhance national economic development agendas. It was believed that technology education "...contributes to the intellectual and practical development of students,

as individuals and as informed members of a technological society” (Ministry of Education, 1995: p. 7). As a consequence, the technology curriculum development process in New Zealand was rigorous and systematic in order to take into account views from a cross section of stakeholders (Jones, 2003). There were efforts to adhere to the social reconstruction curriculum design model as in Zuga (1992), where social problems relevant to technology become the means of organising technical processes. There were consultations with academics, politicians, technologists and the wider community including Maori groups (for Maori technological knowledge) in order to fully embrace the social values and beliefs of New Zealanders. Besides economic and historical factors, political will in the whole process played a significant role as shown by the establishment of a Ministerial task group (Jones, 2003), funding for all the activities leading to the development of the curriculum statement, teacher development programmes, mobilisation of teaching and learning resources, and piloting and implementation of the technology curriculum in schools from 1995. It was an enormous task as the process took into account different philosophies and interest groups.

The National Curriculum in Australia, with its eight key learning areas, technology inclusive, was introduced on the premise for schools to provide a foundation for a skilled, flexible and productive workforce (Cowley & Williamson, 1998; Ginns, Norton, McRobbie, & Davis, 2007). Economic, social and educational pressures, as in many parts of the world, therefore influenced states in Australia to adapt the national curriculum statement to their state curriculum (Ginns, et al., 2007; Treagust & Rennie, 1993). The *Technology for All Americans* (Dugger Jr. & Satchwell, 1996; McCormick, 1993b; Technology for All Americans Project, 2000; Zuga, 1997), emphasized the power and promise of technology and the need for universal technological literacy. As technological knowledge became more specialised and widespread, technology education was proposed to provide Americans with an understanding of what it was and how to make intelligent decisions about it. The industrial arts subject in the United States of America (USA) was considered to have lost the general education purpose and focus as it was predominated by tool instruction and material processing for specific trade skills (Zuga, 1997).

In the Netherlands (de Vries, 1993), the Pedagogical Technological College designed a framework that focussed on technology as a cultural phenomenon and encompassed design, culture, society and use. It has been shown therefore that with a global influence for curriculum change in the 1990s, many countries embraced the change to address prevailing socio-economic problems. The reforms were also largely influenced by political and economic events taking place at the time. As the third world countries are faced with insurmountable socio-economic problems, such as poverty, hunger and HIV/AIDS, shifting the curriculum towards enhancing technological literacy (Lewis, 2000; Petrina, 2000) would help to enhance the youth's democratic potential and capabilities to participate in development activities taking place in their communities including poverty alleviation initiatives. Technology education is therefore seen as a means for enhancing the youth's capabilities to effectively compete in a global village as it becomes increasingly technology based.

Many countries, particularly those in the third world, have maintained the traditional subjects of metalwork, woodwork and technical drawing despite the increasing centrality of technology to global futures (Arum & Shavit, 1995; Canavan & Doherty, 2007; Lewis, 1991; Urevbu, 1988). The rationale for technical education was based on the same ideologies of economic emancipation as espoused in recent movements for technology education. However, it was not known how a technical curriculum would help foster economic growth and development when market forces were exclusively determined by factors outside the school (Urevbu, 1988). The vocationalisation of the school curriculum was also largely influenced by political pressures and international and local associations. For instance African Ministers of Education meeting in Addis Abbaba in 1961 recommended for states to diversify school curriculum as it was believed such a curriculum would lead to economic independence of the nations (Urevbu, 1988). The meeting of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) held in Paris in 1972 also recommended the dovetailing of science teaching and the teaching of technology (Faure, et al., 1972). Faure asserted:

An understanding of technology is vital in the modern world, and must be part of everyone's basic education. Lack of understanding of technological

methods makes one more and more dependent on others in daily life, narrows employment possibilities and increases the danger that the potentially harmful effects of the unrestrained application of technology - for example, alienation of individuals or pollution - will finally become overwhelming (p. 66)

A decade later, the UNESCO conference of Education Ministers in Harare, Zimbabwe in 1982 also emphasized the same goals (Urevbu, 1988). At the outset of independence from colonialism, most nations adopted a comprehensive school curriculum to train skilled workers and mid-level technicians, administrators and bureaucrats. The system was similar to what Hager & Hyland (2003) described as the front-end model, the efficacy of which proved doubtful in the vocational preparation of workers. The model was inconsistent with the nature of workplace practices and the needs for workplace literacy and flexibility (Hager & Hyland, 2003; Lewis, 1997). The political leadership in Africa then also associated technical subjects with Julius Nyerere's (1922-1999) socialist ideology of *Education for Self-Reliance* which was later reviewed and became *Elimu ni Kazi* (Education is Work) (Kerre, 1994; Urevbu, 1988). Nyerere's philosophy for education to help shape the youth's occupations through skills development resonated across Africa. His focus though, was mainly on informal education since many citizens of productive age had not been to school. However, Kerre (1994) had suggested that the systems adopted in many countries were impacted by a lack of a shared understanding among African States and scholars on the meaning of technology education and what a technical and vocational school curriculum entailed. For instance, Kerre's seven cases, which included Botswana, Ethiopia, Kenya, Nigeria, United Republic of Tanzania, Zambia and Zimbabwe, were said to have a variety of curricula with both traditional technical subjects and the modern more general scientific and technological approaches. However, the country perspectives show a more vocational orientation of the curriculum as also depicted in Kerre's use of UNESCO definitions of technical and vocational education:

A comprehensive term referring to the educational process when it involves, in addition to general education, the study of technology and related sciences

and the acquisition of practical skills and knowledge relating to occupations in various sectors of economic and social life (p. 107).

UNESCO's argument about the meaning of technical and vocational education was also in relation to the levels of education. For instance vocational education was for lower secondary school levels while technical education was for upper secondary, tertiary and university levels of the education system. Except for Botswana which established design and technology, the countries in Kerre's cases adopted the general, polytechnic education as it was assumed to guarantee professional mobility leading to lifelong education (Faure et al, 1972).

The effectiveness of vocational curricula compared to general academic curricula remains fraught with uncertainty as to whether successes and failures of national economies may be associated with such systems of education. For example, Botswana, a fast growing economy and one of Kerre's cases, offers design and technology in the community junior secondary schools while the senior secondary schools offer the craft and skills based technical subjects. Botswana's economic success may be attributed to other factors such as the huge diamond reserves, and internationally acclaimed good governance leading to political and macroeconomic stability (Hope, 1996). What is known, however, is that poverty and unemployment continued to escalate in all Kerre's cases and the rest of the third world, despite the promises of such a curriculum (Hope, 1996; Islam & Majeres, 2001; Kerre, 1994). It is, therefore, imminently clear that a paradigm shift is needed, other than maintaining a system that bears little or no fruit when society expects citizens that can support its dynamic and diverse needs for economic growth and development. As technology is a social phenomenon (Jones, 2003; Pavlova, 2005) and an integral part of the social structure, national curricula and Malawi inclusive, should shift towards technology education for social change.

The transition from technical subjects to technology education curricula undertaken in many countries adopted varying models depending on the understanding of the educators, consultants and stakeholders about the nature of technology and technology education. Consensus building was emphasised during the transition from the manual arts to technology education programmes in the

USA and towards the process of establishing technology education as a core subject in the curriculum through the *Technology for All Americans* project (Satchwell & Dugger Jr, 1996; Technology for All Americans Project, 2000). Involvement of mathematics, science, and technology educators from elementary through high school levels included a series of consensus building workshops in order to cultivate a common understanding of the nature of technology. Despite such initiatives, Zuga (1997) reported that the change process did not reach the classrooms by the time the new curriculum was introduced as the underlying belief systems that support technology were not addressed. New Zealand used the centre-peripheral approach with a higher success rate as key facilitators designed and implemented school based programmes based on *Technology in the New Zealand Curriculum* (Jones, 2003; Ministry of Education, 1995). As in the USA's technology standards, experts in Australia developed a statement on technology for Australian schools, and implementation was a prerogative of the state authorities (Australian Education Council, 1994). In the UK, the British National Curriculum prescribed the technology structure and curricula content for all schools (Lewis, 1996; Treagust & Rennie, 1993). However, research (for example, Canavan & Doherty, 2007; Mittell & Penny, 1997; Paechter, 1995) reported a disjunction between policy and practice and also tendencies of teachers' sub-cultural factors which threatened a decline in technological studies. Therefore, lack of a technology statement in Malawi creates a situation conducive for a review process to be informed by classroom practices. Hence, gauging the perceptions of students and teachers may help in establishing pre-existing teaching and learning practices that may influence understanding of the nature of technology and learning approaches in the Malawian context.

2.3 Students' perceptions towards technology

Studies on students' perceptions towards technology have been conducted in many countries (Ankiewicz, van Rensburg, & Myburgh, 2001; Becker & Maunsaiyat, 2002; 1998; Burns, 1992; Raat, de Vries, & Alting, 1985). The impact of technology on the current and future lives of society's youth is potentially huge, making it especially important to understand technology and professional practice from the students' perspective (Frantom, et al., 2002). Studies have found that students' interests have a bearing on their learning and

their perceptions need to be accounted for when teaching technology. Boser et al. (1998: 6) observed that "...students who have a positive experience in a technology education programme will develop a positive attitude toward technology and the pursuit of technological careers, and would therefore be more interested in studying about technology". Lewis (1999) also pointed out that understanding the conceptions that students have about aspects of the subject matter of technology is an important prerequisite for better teaching and improved learning.

Studies were conducted in order to incorporate in the curriculum stakeholders' views and interests that have a bearing on societal needs and on the teaching and learning implications of technology (Becker & Maunsaiyat, 2002; Burns, 1992). An early study was conducted under the Physics and Technology Project at the Eindhoven University of Technology in the Netherlands (Raat, et al., 1985). Raat et al. (1985) investigated 13-year-old students' attitudes towards technology using the Pupils' Attitude towards Technology (PATT) questionnaire and revealed that the students perceived technology as a broad, diverse, important and not too difficult subject. The students expressed interest in having it taught in schools. Raat et al. also found that girls were less interested in technology than boys. Parental technical education and job backgrounds also influenced the students' views. Differences in perception by gender, and the home and school environments had significant effects on students' attitudes and conceptualisation of technology. Follow-up PATT studies were done in 20 other countries including Nigeria, Kenya and New Zealand. These three countries and many others countries were offering prevocational curricula based on developments in the UK at the time (Raat, de Klerk Wolters, & de Vries, 1987). Raat et al. (1987) indicated that Kenya was working towards introducing industrial education while Nigeria, since 1982, had been offering a prevocational subject called "Introductory Technology" (p. 65) for 11-13 year olds.

In Hong Kong (HK), Volk and Yip (1999) reported significant gender differences in attitudes towards technology. In another PATT-HK study (Volk, Yip, & Lo, 2003), differences in attitudes were said to be decreasing with exposure to computer and design and technology instruction. In the Gauteng Province - RSA (van Rensburg, Ankiewicz, & Myburgh, 1999) there were no significant

differences in attitudes towards technology with more girls having positive attitudes. van Rensburg et al. (1999) also indicated that girls viewed boys as more competent in technology education and this was attributed to the South African female value judgement attributed to their lack of self-image. Based on their findings, van Rensburg et al. therefore proposed the need for directions to influence South African girls to have a more positive self-image. However, the role of learning in technology towards enhancing girls' image may also be hindered or facilitated by motivational beliefs, classroom environment and other factors (Pintrich, Marx, & Boyle, 1993). The girls' image, though, may have been influenced by persistent patterns of sexual divisions of labour which characterise human society (Bush, 1983; Cockburn, 1991; Kline, 2003; Wajcman, 1991). Stereotypical social expectations also encourage girls to be concerned with everyday human needs (Murphy, 1993). For example, Murphy showed that during a task that involved designing model boats to go round the world, boys designed powerboats or battleships with heavy weaponry and mechanistic details, while girls' boats were cruisers with a great deal of detail about living quarters and requirements including food supplies and cleaning materials. Besides the need for adapting the PATT instrument, research on the cultural dynamics and intergenerational influences on how boys and girls perceive and learn technology (Petrina, Feng, & Kim, 2008) may help in understanding girls' images of technology and so reduce the gender gap.

Synthesis of findings of the PATT studies conducted across the globe show that the students have positive attitudes towards technology and technology education but narrow or limited conceptions of the nature of technology (Bame, Dugger, de Vries, & McBee, 1993; Mather, 1995; Raat, et al., 1987; Solomonidou & Tassios, 2007). In the RSA context, PATT studies yielded invalid and unreliable data, and adaption was therefore recommended leading to the development of the Attitudinal Technology Profile (Ankiewicz, et al., 2001). The studies however do not show how confounding variables (for example, teacher pedagogical content knowledge and teaching and learning resources) were accounted for in order to mitigate their effects on the analysis. Worldwide findings of the PATT studies could also have been influenced by the teachers' limited concepts of technology which may hinder students' learning, and because there is no shared

understanding of the concepts of technology between students and teachers (Jarvis & Rennie, 1996). Therefore teachers' professional development needs to focus on changing students' views of technology, on reducing gender and other forms of differences in perceptions and on broadening students' concepts of technology and technology education.

Jones (1997) argued that dispositions towards and perceptions of phenomena and problems are significantly affected by students' conceptual knowledge of technology. However, students' perceptions and dispositions regarding the concepts and nature of technology may not be sustained unless the students become independent, creative thinkers, lifelong motivated learners who are able to engage with profound social and cultural changes attributed to the impact of technological advancement (Dow, 2006b). Teaching programmes based on social views of learning (Brown, Collins, & Duguid, 1989; Hennessy, 1993; Perkins, Jay, & Tishman, 1993; The Cognition and Technology Group at Vanderbilt, 1990) may help empower students to think. In addition, technological activities must be culturally meaningful, important and relate to the technological world outside the school. Situated cognition should therefore be taken into account in teaching technology programmes as knowledge embedded in the context in which learning occurs becomes more meaningful to the learners (McCormick, 2004). The goal for instruction towards technological capability should therefore be to develop transferability of knowledge (generality) either in a classroom situation or in life after school (Perkins & Salomon, 1989). Students' foresightedness over the benefits of learning and engaging in technological activities may help enhance their interest towards the attainment of further technological literacy.

To build students' interest in technology, teaching needs to include a variety of teaching styles as has been indicated in the literature. For example, technology fairs adapted from the science fairs influenced pre-service teachers' learning in technology (Mettas & Constantinou, 2008). As technology is both collaborative and cooperative in nature (Jones & Carr, 1993a), classroom approaches should be flexible and open in order to accommodate students' interests, aspirations, learning styles and socially constructed factors such as gender stereotypes. However, the implementation of any classroom approach is a factor of teachers' pedagogical reasoning, comprehension and actions (Shulman, 1987). An

understanding of teachers' perceptions of technology and their classroom practices should therefore help map out the pedagogical needs to be incorporated in a professional development programme.

2.4 Teachers' Perceptions towards Technology and Technology Education

Teacher and curriculum developments in technology education in New Zealand, England, Wales and many other countries have reflected on the perceptions of teachers (Jones & Carr, 1993c; Paechter, 1995). Essentially, influences of past experiences, attitudes towards change, teacher involvement and preparedness to take risks have been major features for understanding teachers' perceptions towards technology education and its implementation. Curriculum change and consequently teaching and learning in technology have largely been influenced by competing ideologies which Paechter (1995) described as subject subcultures. According to Paechter, "such subcultures represent contested but more-or-less consensus views about such things as the nature of the subject, the way it should be taught, the role of the teacher and what might be expected of the student" (p. 75). Subcultures were also seen by Paechter as contributing to power, control and status of teachers of technology during the negotiation and development of design and technology as a new curriculum area, leading to implementation hitches and retreating to original subject subcultures. Canavan and Doherty (2007) observed that the technical education departments in Scotland were struggling for a unified identity. Teachers in the departments were said to be fragmented and polarised with multiple agendas based around personal preferences, subject confidence, individual skills and knowledge. Some technical teachers were even proposing a return of the craft and skills based curriculum and to a decline or scrapping of technological studies. A review of inspection findings in England and Wales showed that a disjunction between design and technology policy statements and classroom practice existed as teachers appeared to value prescriptive craft skills (Mittell & Penny, 1997). Teachers showed restricted conceptions of the purpose of design and technology, as outcomes were defined in product specific terms. An understanding of the teachers' perceptions therefore helps to determine prevalent subcultures to avoid repackaging old curriculum habits into a new learning area.

In New Zealand, the views of teachers on approaches to introducing technology were influenced by their perceptions of technology education which were largely attributed to their subject subcultures (Jones & Carr, 1993c). For instance, science teachers saw technology in terms of applications to science while social studies teachers emphasised social aspects of technology. English teachers associated it with media studies, journalism and drama while technical teachers emphasized aspects related to skills, designing and making. This calls for specialised technology teachers' training programmes as non-professional teachers of technology are less likely to meaningfully teach students effective dispositions for transfer of technological knowledge. Jones (1997) also raised issues of classroom culture, modelling and technological problem solving using authentic activities and contexts which teachers from other cultures may not articulate adequately. Jones and Carr (1993c) therefore suggested that implementation of a technology curriculum must take into account subjective realities of the teachers on the ground in determining curriculum and pre-service and in-service teacher training programmes including professional development. As perceptions directly influence classroom practices and subsequent learning in technological concepts and processes, positive views may help teachers to conceptualise teaching and learning that imparts thinking skills for students' active engagement in a technologically mediated sphere (Dow, 2006a; Jones, 1997; Stein, Ginns, & McDonald, 2007). Understanding teachers' cultures, beliefs and practices appears to be helpful in developing teachers' perceptions and their readiness to shift from a prescriptive craft based curriculum. This aspect could be mitigated during curriculum change with teachers' active engagement in the review and implementation processes taking into consideration their experiences, existing beliefs and practices. Therefore, the section below reviews literature related to learning in technology to help map out what and how teaching and learning technology entails and which underpins understandings of approaches for developing perceptions and practices consistent with their existing sub-cultural realities.

2.5 Learning in Technology

In this section I will discuss issues of learning and curriculum in technology education and will focus on concepts of knowledge, social views of learning,

generality and the curriculum influences. The theoretical perspectives on technology education will also be presented. Some of the theories to be discussed include situated cognition, cognitive apprenticeship, communities of practice, and anchored instruction. Although most research work over the years has focussed on policy, curriculum implementation and teacher training (Jones, 1997), a lot of work on learning theories was done in other domains such as science, mathematics, language and literature. These studies may therefore equally inform research and learning in technology education. However it is still imperative that research in technology education be focussed on learning, the nature of technological knowledge and classroom practices to help teachers develop broader views of teaching and learning technology. This section therefore also reviews related research work, although in other fields, from which learning strategies in technology education may be adapted.

2.5.1 Concepts of Knowledge

Theorising the nature of knowledge is a complex issue due to its representation and in some cases its idiosyncratic constructions (Solomon, 1998). Solomon argues:

It is not so much what one knows but whether one knows how to get to the knowledge and whether one knows what to do with it once it has been accessed...is not just an accumulation of facts...having been constructed for idle purposes, sitting there to be called upon; rather knowledge is sought after, accessed, and situationally and purposefully constructed *ad hoc* (p. 5).

Bereiter (1992), Glaser (1993) and McCormick (1997) theorised and categorised the concepts of knowledge into referent-centred, problem-centred, conceptual or declarative and procedural knowledge, connectionism and associationistic theories. Referent-centred knowledge is conceptual - that which is learnt through observing an expert or a teacher, while problem-centred knowledge is procedural or know-how and learnt through imitation, coaching and practice (McCormick, 1997). For declarative or conceptual knowledge, students rely on teachers as experts, and rote and passive learning have often become the norm in these classrooms. However, G. F. Smith (2002) asserted that “Effective thinking requires knowledge of concepts, principles, standards and other forms of

declarative knowledge, and of heuristics that are less proceduralized than skills” (p. 676). Procedural knowledge allows the students to construct their own knowledge over and above schemata. Bereiter (1992) asserted that:

...growth in mastery of the concept will be marked by increased accuracy in recognising problems to which the concept does and does not apply. Indeed as referent centred knowledge, the concept is quite vacuous - much like the concept of gravity. It only requires substance as it becomes linked to the problems it helps to solve. (p.358)

Therefore referent or conceptual knowledge and problem centred or procedural knowledge may not be acquired in isolation. A critical understanding of a concept leads to a thorough process, and emphasis of one concept in isolation limits effective learning. Hence, the associationistic and connectionism theories of learning show greater interaction between knowledge, cognitive processes and direct experiences (Glaser, 1993). Glaser argued that schemata assist in understanding how cognitive structures facilitate the use of knowledge. Mostly, individuals use lived experiences to develop meanings of related events. McCormick (1997) pointed out that device knowledge (operation) makes fault finding (problem solving) successful, although dependent on self-regulatory and meta-cognitive capabilities of the students. A rule of thumb may not support some operations as it also encourages rote learning and memorisation of facts with less possibility of skills or knowledge transfer to other life situations. Situated cognition, cognitive apprenticeship and anchored instruction expose students to learning which can be integrated in unique situations. Technology education should make full use of the interaction using problem solving and design concepts which are essential to learning in technology. Students should be empowered to think and reason (Glaser, 1993; G. F. Smith, 2002) in order to apply the acquired knowledge in various social contexts.

2.5.2 Social Views of Learning

Social views of learning provide an explanation of the relationship between knowledge and the conceptual environment or the situations in which it is learnt and applied. Learning is considered a social process where interactions between individuals are both the means for, and the results of, learning (Wertsch, del Río,

& Alvarez, 1995). According to Solomon (1998) “learning is not just an intra-individual affair, but at least as much an inter-individual one...meaning is said to be socially appropriated...it is assumed to be embedded in social activities” (p. 6). Brown et al. (1989), Hennessy (1993), Lave (1991) and Perkins et al. (1993) described situated cognition, cognitive apprenticeship and good thinking as important instruments for promoting social views of learning. Brown et al. (1993) argued that “knowledge is situated, being in part a product of activity, context and culture in which it is developed and used” (p. 32). Enculturation fosters learning where, according to Brown et al. (1989), students “observe and practice in situ the behaviour of members of a culture, people pick up relevant jargon, imitate behaviour and gradually start to act in accordance with its norms” (p.34). It is therefore imperative that activities are authentic and properly structured to provide experience for subsequent learning. Brown et al. therefore proposed the notion of cognitive apprenticeship and collaborative learning in order to situate cognition. According to Brown et al. cognitive apprenticeship involves situated modelling, coaching and fading and teachers promote learning through the use of authentic activities. Besides epistemological problems of situated cognition (Brown, et al., 1989), teachers of technology may lack pedagogic skills to situate cognition. As knowledge is assumed to be embedded in social activities, teachers need to comprehend the community of practice from which they can draw situations to contextualise learning (Lave & Wenger, 1991; Wenger, 1999). Lave (1991) argued that “learning, thinking, and knowing are relations among people engaged in activity in, with, and arising from society and culturally structured worlds” (p67). It was also observed from Lave (1991) that:

...a decentred view of the locus and meaning of learning, in which learning is recognised as a social phenomenon constituted in the experienced, lived-in world, through legitimate peripheral participation in on-going social practice; the process of changing knowledgeable skill is subsumed in the process of changing identity and through membership in a community of practitioners; and mastery is an organisational, relational characteristic of communities of practice. (p.64)

Situated learning in technology education may therefore help learners to develop knowledge in contexts and settings where that knowledge would be useful. As

learning is a process of enculturation into a domain (McCormick, 2004), engagement in authentic technological activities helps establish a sense of belonging to a community where learners want to become members. Teachers, as models in the technological world, should be conversant with social practices from which learning issues and problems are derived and in the process, help integrate the students - considered as new-comers or novices - in their anticipated communities of practice.

Perkins et al. (1993) provides a theory of good thinking based on the concept of dispositions which depend on general and specific abilities. Perkins et al. (1993) illustrated the theory by looking at Charles Darwin's tale where he popped a beetle in his mouth (which he used as a container) for entomological enquiry. Perkins et al. defined dispositions as "...behavioural tendencies: the tendency to cheat or play straight, the tendency to be bold or cautious, the tendency to give thinking time, to consider broader perspectives, to seek evidence vigorously and so on" (p2). As "tendencies towards intellectual activity that guide cognitive behaviour specifically" (p6), Darwin's behaviour showed good thinking as he was adventurous and his ingenuity enabled him to devise a container for a beetle from the surroundings. His wide knowledge and experiences were applied specifically. Good thinking should therefore be emphasised in technology to enhance students' flexibility and adaptability as in Darwin's case. Cognitive apprenticeship, where learning involves modelling, coaching, scaffolding, fading, articulation and encouraging learners to reflect on their own problem solving strategies (Hennessy, 1993), could be employed to develop technological capabilities and dispositions. Hennessy confirms that cognitive activities are socially defined, interpreted and supported and that prior knowledge and experience are pivotal to learning.

2.5.3 Generality

The issue of generality focuses on the transferability of knowledge from one domain to another either in a classroom situation or in life after school. However, generality is affected by methods or models of teaching and learning, and situated cognition, apprenticeship and problem solving seem to play a critical role. Research into these concepts of learning and related implications for technology education, have shown the need for contextualisation of learning (Hennessy,

McCormick, & Murphy, 1993; Jones, 1997; Perkins & Salomon, 1989; The Cognition and Technology Group at Vanderbilt, 1990).

Research has also shown debate about problem solving in relation to knowledge acquisition in technology education (Hennessy, et al., 1993). It has been argued that problem based teaching and problem-based learning with a focus on procedural knowledge, rather than conceptual knowledge, fosters generality and hence transferability of knowledge and skills, not only across the curriculum, but also in life after school. Hennessy et al. (1993) for example argued that situated cognition is the tool for transferability since contextualised learning makes theories and concepts relevant to daily life applications. Cognitive acceleration and apprenticeship have been tried successfully through science learning and mathematics, and language learning respectively. Design and problem solving practices in technology education may be explored to enhance generality and meta-cognitive skills (Hennessy, et al., 1993). Problem solving practices that foster creativity may help to encourage good thinking and also to promote transferability of technological knowledge. G.F. Smith (2002) also argued that: "Generalizable thinking skills must be taught *explicitly*, and the teaching must include direct applications to practical affairs for transfer to occur" (p.674).

Perkins and Salomon (1989) explored the generality of cognitive skills and whether skilful thought is context bound. Perkins and Salomon used an analogue of a chess master to out-think an enemy using a military principle which is based on chess tactics of centre control. According to Perkins and Salomon, general knowledge includes widely applicable strategies for problem solving, inventive thinking, decision making, learning and good mental management sometimes called auto-control, auto-regulation or meta-cognition. The main factor for generality however, is transferability with such characteristics as common use, important role, transferable, and commonly absent. An activity that meets all these factors was considered general and the acquired knowledge appeared to provide general tools for functioning in other domains or situations. Darwin, in Perkins et al. (1993), possessed many of these tools - and showed functional flexibility when he popped a beetle in his mouth. Perkins and Salomon (1989) and Perkins et al. (1993) therefore showed that contextualised knowledge has a high possibility of transfer. Generality in technology education can therefore be easily attained using

contextualised and authentic problem solving techniques which can be enhanced through cognitive apprenticeship. Jones (1997) proposes that future research should focus on learning in technology, which may help to explore and fully clarify the relationships and how students can be taught to think in order to function flexibly and control their learning like the chess master.

The Cognition and Technology Group at Vanderbilt (1990) explored ways of anchoring instruction to support cognitive apprenticeship programmes with the aim of developing students' confidence, skills and knowledge necessary to solve problems and become independent thinkers. The Cognition and Technology Group at Vanderbilt used video based instruction with environments for cooperative learning and teacher assisted instruction. Text messages were not used because of the disadvantage of representing the writers' pattern of recognition process but the video photographer also needed to mitigate selection biases. Video represents modern technology that attracts students and could therefore be used to enhance their learning of content. Two cases of anchored instruction, the Young Sherlock Project and the Jasper Series, analysed learning in language and social studies, and mathematics respectively. The cases present the same challenges of transferring knowledge from other domains to technology education and a replication of these projects in technology education research may help to inform the design of appropriate pedagogy. Technological knowledge should be contextualised to enhance its transferability.

Jones (1997) has shown that technology education is fertile for research. Most research studies were conducted in mathematics, science or language development, in order to define the generality or contextualisation of knowledge. Technology related research focussed primarily on policy and curriculum but recently, research has also provided insights on learning and cognition in technology (McCormick, 2004; Petrina, et al., 2008; Zuga, 2004). Such research also helps inform new policy and curriculum developments, particularly in countries where technology is yet to be established as a learning area.

2.5.4 Curriculum Influences

Curriculum designs in the past were largely influenced by economic and political developments while educational, environmental and cultural concerns were given

little attention. Zuga (1989) indicated that early industrial arts goals focussed on 'career exploration and vocation, consumerism and skills development, and heavily emphasized the purpose of the subject matter as prevocational study' (p. 1). It was believed that the comprehensive curriculum would enable students to gain employable skills and therefore provide human resource for the growing industrial economies. According to Barnett (1994) technical education curriculum embraced "technical performance while consigning the purpose and outcomes of technology activity to the shadows" (p.51). For the past two decades, the developed world has been going through a paradigm shift over the goals of industrial arts/technology education and Jones and Carr (1993a) asserted that:

People need to be able to translate ideas into action, to cooperate in their work, and to adapt to a rapidly changing world. Our economic future depends on developing product and market niches. This argument points to the value of the interaction of school students with the commercial world (p.1).

Barnet (1994) and Jones and Carr (1993a) therefore agree on the realism of technology education where the business and wider community as producers and consumers demand better value for their products and services. Technological literacy is therefore a tool for empowering society to understand and control the manipulation of their values through and with technology (Barnett, 1994; Fleming, 1989). In order to address the need for social values in the technology curricula, an appropriate design model needs to be adapted - a model that embraces a socio-technological system.

Alternative versions for curriculum design were proposed by S.D. Johnson (1992) Petrina (Petrina, 1992) and Zuga (1992). These included an intellectual processes curriculum, a personal relevance curriculum, and a social reconstruction curriculum respectively. S.D. Johnson (1992) deduced that the most important skill for the future is thinking, and this is the basis for an intellectual processes curriculum which focuses on mental operations, critical and creative thinking, and meta-cognition. In general, however, students need to be taught to think through the use of situated cognition, cognitive apprenticeship and anchored cognition

(Brown, et al., 1989; Hennessy, 1993; Lave, 1991; Perkins, et al., 1993; The Cognition and Technology Group at Vanderbilt, 1990).

Petrina (1992) proposed personal relevance curriculum designs and asserted that the designs are compatible with most missions and philosophical statements for technology education but few if any curriculum plans, emphasize this design. The design emphasizes personal growth, integrity, autonomy and unique meaning. Personal growth embraces self-actualization, autonomy, authenticity, health and happiness. Students learning in a design with these emphases are free to develop their own curricula based on their personal problems, developmental levels, goals, interests, curiosities, capabilities and needs. The development of the curriculum focuses on participation, integration, relevance, and encourages a teacher-student-community interaction, deliberation and discourse (Petrina, 1992). Although the New Zealand curriculum was developed through a centre-peripheral approach (Jones, 2003), the processes and content reflect the personal relevance curriculum in an integrated approach with units that are experience-based, addressing societal, citizenship, and child centred curriculum needs.

Zuga (1992) presents a social reconstruction curriculum that focuses on active participation through doing, but with a social purpose as opposed to a personal relevance curriculum. In construction, the thrust of Zuga's model would be, for example, designing and constructing low cost housing for the homeless, refurbishing low cost housing or retrofitting housing with energy saving devices. Learning in technology should therefore evolve around the social problems facing communities and this draws on the political nature and value of technology aimed at providing social and amenable services to people. It focuses on critical consumerism and the consideration of social unions. Technology therefore exposes students to solving community problems at an early stage, thereby fostering citizenship and development.

An integration of the three curriculum designs would culminate in a rich and broad curriculum, since leaving out one may limit the scope of curriculum thereby depriving students of essential practices and experiences. Therefore an intellectual processes curriculum sandwiched with personal relevance and social construction perspectives would put to rest the criticisms over technology as argued by Barnett

(1994), that “Technology is more often accused than applauded and is seen as being variously implicated in increased threats to survival from the old enemies, war, famine, plague, fire and flood” (p. 55). However curriculum design processes are largely influenced by prevailing political, economic, environmental and socio-cultural conditions. Curricula that address the needs of social groups in society may stand the test of time and hence the need for rigorous consultative processes in order to incorporate views of all stakeholders. Dusek (2006) pointed out that:

...theories and models are conceptually constructed. Insofar as concepts of others are utilised, past or contemporary, this construction is also social. Furthermore, because of the active, manipulative nature of technology, techniques, guiding principles, concepts and theories are embedded in the physical construction of technological artefacts. The interpenetration of socially constructed concepts and socially constructed devices is clearly evident in technology (p. 204).

Dusek (2006) shows that technology is socially constructed and therefore technology education should be seen to promote its socially constructed nature - the New Zealand curriculum has fully embraced this notion. Teacher professional development is therefore critical in influencing teacher change towards understanding technology phenomena and pedagogy for technology education.

2.6 Teacher Professional Development

Professional development of teachers is a phenomenon widely recognised as a means of enhancing quality teaching and learning and also for introducing change and curriculum reforms (Borko, 2004; Ingvarson, Meiers, & Beavis, 2005). Recent research on professional development shows a focus on how to deliver effective professional learning to improve teaching practices through an emphasis on content, pedagogy and professional development processes (Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Stein, et al., 2007). However professional development programmes based on curriculum reforms in many education systems have largely failed to also reform teachers’ beliefs, values and practices for better student achievement (Al-Daami & Wallace, 2007; Macdonald, 2003) . Macdonald (2003) attributed the trend to varying approaches to curriculum reform: ‘top-down’, ‘bottom-up’, or ‘partnership’ (p.143) that focus much on the

subjects and modernist structures of schools when such reforms demand a great deal of teacher learning to adapt traditional beliefs and practices with new ones. In a top-down model, teachers have been mere observers as reported by Al-Daami & Wallace (2007) on the Jordanian centralized and hierarchical curriculum reforms. According to Macdonald (2003), the top-down model leads to a teacher proof curriculum developed by specialists and planted into the classroom. The bottom-up model involves all stakeholders while the partnership model tends to use both bottom-up and top-down. Macdonald suggested post-modern curriculum reform practices that promotes interactions and allows students to become knowledge producers by transformative change attained through the actions of learners. Teachers are hence pivotal in the reification of a curriculum of that nature and teachers need support to enable them to unlearn their beliefs and values (Macdonald, 2003). Therefore, Bybee and Loucks-Horsley (2000) and Garet, Porter, Desimone, Birman and Yoon (2001) considered professional development as an essential mechanism for deepening teachers' understanding of theories and practices that underpin the curriculum, enhancing their content knowledge, and also developing teaching practices appropriate for student learning of technology.

The teachers' knowledge and application of the theories of learning and varied teaching styles depends on their pedagogical content knowledge (PCK). According to Shulman (1987), PCK is the fourth element in a knowledge base for teaching. The elements consist of content knowledge, general pedagogical knowledge, curriculum knowledge, PCK, knowledge of learners and their characteristics, knowledge of educational contexts, and knowledge of educational ends, purposes and values, and their philosophical and historical grounds. Shulman (1987) describes PCK:

Among other categories, pedagogical content knowledge...identifies the distinctive bodies of knowledge for teaching. It represents a blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented and adapted to the diverse interests and abilities of learners, and presented for instruction (p.8).

Moreland and Jones (2000) asserted that, for a new curriculum area such as technology, the blending of content and pedagogy presents particular challenges

for teachers as they search to construct a coherent, technological content base. Moreland and Jones hence argued that knowledge of the nature of technology and technological practice, knowledge of technological concepts and processes, and general pedagogical knowledge are central to effective teaching of technology. Ginns et al. (2007) also asserted that teachers' possession of a personal knowledge and understanding of the content and processes of design and technology, and related PCK and pedagogical knowledge, guarantees the successful implementation of technology as a learning area and ensures students' attainment of a basic understanding of technology. When technology education was a new subject area in New Zealand, teacher professional development programmes were implemented to help teachers teach from the new curriculum (for example, Compton & Jones, 1998; Jones, 2003; Moreland, 2003). Compton and Jones (1998) reported on technology professional development programmes that focussed on teachers developing an understanding of both technological practice and technology education. These professional development programmes included the national facilitator training programme and the technology teacher development resource package. The facilitators programme trained educators to facilitate school-based teacher development in technology education. The facilitators programme included facilitators undertaking a Masters paper and workshops in technology education. They trialled a teacher development programme developed in their own school and after that in other schools. These professional development programmes interspaced workshops between teaching practices. The facilitators and teachers shared and reflected on their own and each other's experiences. The second programme consisted of written modules and supporting videos covering technological practice, technology education and technology education pedagogy. These programmes were introduced to teachers and were successful as they helped teachers to experience, reflect on and critically analyse concepts of technology and technological practice (Jones, 2003).

Jones and Moreland (2001) also reported on strategies they developed with teachers to sustain those teachers learning in technology. The strategies included: "...reflecting on their own and others classroom practice; using a planning framework; negotiating interventions in the classroom; involvement in workshops; providing classroom support; involvement in teacher agreement

meetings; using student portfolios; and summative profiling” (p. 261). Jones and Moreland reported enhanced student learning in technology as a result of increased teacher PCK and highlighted the importance of teacher knowledge of the subject matter, curriculum, learners and pedagogy.

The Learning in Science Project (Bell & Gilbert, 1994) investigated the development of teachers of science as they learnt new teaching techniques for enhancing students’ thinking. The teacher development programme, devised to develop teachers’ knowledge and practices, comprised meetings where teachers shared new teaching activities tried in their classrooms, workshop activities and also classroom visits made by teachers to classrooms of other teachers. According to Bell and Gilbert the programme was successful in bringing about teacher change because it attended to the professional, social and personal development of the teachers. The programme also provided opportunities for on-going support, reflection and feedback. Compton and Jones (1998) also recognised these components as important for fostering teacher change and enhancing classroom practice in technology education teacher development. Providing opportunities for teachers to work collaboratively with peers and educational experts also underpinned the success of the Developing Professional Thinking for Technology Teachers (DEPTH) model (Williams, 2008) and these were considered essential for adopting new classroom practices.

The successful teacher development features in Bell and Gilbert (1994) may also be strengthened through co-teaching. Co-teaching is based on social constructivism and learning communities of practice (Tobin & Roth, 2005). It involves teachers teaching together and sharing teaching responsibilities such as planning, the teaching process and evaluation. According to Tobin and Roth, teachers also need to undertake co-generative dialoguing to help them reflect on experiences and plan next actions. Co-teaching is a recognised tool for teacher development and also teacher preparation (Beers, 2005; Tobin & Roth, 2005).

Robertson, Trotman and Galbraith (1997) advocated action research as a tool for school and teacher professional development. Action research was believed to be a powerful means of building learning communities and influencing practice. Teachers search for and try out solutions to own questions leading to their

developing a professional body of knowledge and a commitment to continued renewal, learning and growth (Robertson, et al., 1997). However, as teachers independently carry out action research (Johnston, 1994) outside influence through facilitation and support teams may limit legitimising and ownership of the research. It is also noted that the transition from a teacher to a scholar is not an easy task considering the normative nature of teaching and analytical practices distinctly needed in research (Labaree, 2003). Labaree however, pointed out that teachers bring into research ideal traits which include maturity, professional experience and commitment. Action research also gives the teachers voice and involvement in the transformation of the school, its curriculum and the society it embodies as long as they set their own research agenda (Bishop, 1997; Guba & Lincoln, 2005; Lather, 1992; Noffke, 1997). It is therefore necessary for this study to explore, develop and implement an appropriate teacher development model based on an appropriate theoretical framework to foster change in teaching practices and promote continuous professional development and growth. Teachers with limited understanding of the phenomenon of technology would struggle to conceptualise the learning area (Ginns, et al., 2007) and hence pose a problem towards the implementation of technology as a school subject. Therefore, besides enhancing the teachers' understanding of the subject matter, it is essential to sustain the changes that will result from the professional development. Banks (2008) and Williams (2008) suggested the DEPTH structure based on the user-design approach to change. According to Williams, "User-design is founded on systems theory and thinking and assumes that users should be responsible for creating their own systems of learning" (p.4). The design enhances the quality and relevance of ideas to the context and helps ensure diffusion and sustainability. Socio-cultural theories of learning and adult-learning theories (Trotter, 2006; Wenger, 1999; Williams, 2008), are therefore critical for enhancing reflection and inquiry and promoting individual and community development.

The professional development will however face a number of challenges, as the process in Malawi is unique in the sense that there is no technology order or curriculum in place for teachers to implement. In New Zealand, USA, UK, Australia and RSA national commissions, education associations and research consultations have been officially sanctioned and mandated to develop national

curriculum statements (Ankiewicz, 1995; Dakers, 2006; Jones, 2003; International Technology Association, Technology for All Americans Project, 2000; Treagust & Rennie, 1993). Unlike these countries, the study will exploit current practices from which to negotiate change to learning in technology. A socio-cultural framework therefore underpins the success of the discourse leading to a proposal for a transition from technical subjects to a broad based technology education. The section below discusses the theoretical framework to be adopted for the study and this also helps understanding of research approaches that underpin the social nature of technology.

2.7 Theoretical Framework

As technology is a social phenomenon and an integral part of the social structure (Jones, 2003; Pavlova, 2005), in which social views of learning are being emphasised, it is appropriate for research in technology education to be situated in a socio-cultural perspective (Wenger, 1999). Wenger discussed the social theory of learning based on the perspective that learning is, in its essence, a fundamentally social phenomenon. According to Wenger, learning involves active participation in practices of social communities and constructing identities in relation to such communities. Wertsch et al. (1995) also considered learning as a social process where interactions between individuals are both the means for, and the results of, learning. As the world is socially constituted (Lave, 1991), "...learning, thinking, and knowing are relations among people engaged in activity in, with, and arising from socially and culturally structured world" (p. 67).

Learning in technical subjects formed into a culture and belief amongst students, teachers and the entire education fraternity that craft and skills based practices were considered a tool for economic emancipation (Godwin, 1990; Kerre, 1994; Urevbu, 1988). The study proposes the establishment of a new pedagogy where learning underpins technology for students' enhanced technological literacy. That shift requires a theoretical framework that will not only result in reifications of the new classroom practices but also sustain and promote personal and institutional growth and development. Fernandez, Ritchie and Barker (2008) asserted that:

If, in this dynamic situation, a reification of a design for practice is merely presented to a community of practice without intersubjective linkage with

its designers, we have suggested that then both the extent and form of any change in practice will be compromised during dereification (p. 23).

The engagement of members of the community of practice during curriculum reifications is considered important for the members' commitment to curriculum change (Fernandez, et al., 2008). A framework therefore based on the three socio-cultural planes - participatory appropriation, guided participation and apprenticeship, suggested by Rogoff (1995) is argued as appropriate in this study in order to generate a discourse leading to technology curriculum design. Rogoff (1995) suggested apprenticeship, guided participation and participatory appropriation as inseparable concepts reflecting different planes of focus in socio-cultural activity at community/institution, interpersonal and personal level. The approach is based on consideration of personal, interpersonal, and community planes of focus in the analysis of development processes involved in the participation of individuals with others in cultural practices. According to Rogoff (1995),

The metaphor of apprenticeship provides a model in the place of community activity, involving active individuals participating with others in culturally organised activity that has as part of its purpose the development of mature participation in the activity by the less experienced people (p.142).

Rogoff (1995) also argued that guided participation "...stresses the mutual involvement of individuals and their social partners, communicating and coordinating their involvement as they participate in socio-culturally structured collective activity" (p. 146). In the appropriation perspective, Rogoff views development as a dynamic, active, mutual process involved in peoples' participation in cultural activities unlike the internalisation perspective where, as in Fernandez et al (2008), reifications of the community of practice were seen as a black box. According to Fernandez et al, lack of transparency limits the engagement of curriculum users and the negotiation of meanings is often curtailed. Fernandez et al. further argued that it is the teachers' reification of the curriculum document that is critical to the ultimate direction of changes in practice. As there is no technology culture, nor any curriculum order for technology, understanding students' and teachers' perceptions towards technology

helps to create an opportunity for discourse leading to mutual engagement for the negotiation of a shared and common identity (Rogoff, 1995; Wenger, 1999; Wertsch, et al., 1995). A socio-cultural theoretical framework helps the building of strong professional communities (Borko, 2004) which can foster teachers' learning, enabling them to effect new classroom practices for enhancing students' learning in technology. As the study will involve multiple perspectives and units of analysis (Borko, 2004), a socio-cultural framework was therefore considered helpful in examining the social contexts of the technology classroom and patterns of participation in learning activities.

2.8 Summary

The literature reviewed above has shown that understanding the perceptions of students and teachers towards technology and technology education helps in the design and implementation of the technology curriculum. PATT studies conducted across the globe have shown that students have positive attitudes towards technology but hold a limited understanding of the nature of technology. Students would therefore benefit from programmes that enhance their attitudes and also broaden their understanding of technology through teaching and learning that emphasises technological literacy. The teachers' technological PCK is therefore critical as teachers' subject subcultures have been shown to influence classroom practices. Effective professional development models are hence a prerequisite for influencing teacher change and lifelong learning as teachers with limited knowledge of the phenomenon of technology would conceptualise learning of the new subject in a different perspective. The review has also shown that the paradigm shift from technical education to technology education curriculum was influenced by political, economic and educational ideologies. There have also been attempts to address environmental issues and society values and beliefs which were largely side-lined in the teaching of technical subjects as emphasis was on craft skills development. As technology is a social phenomenon and an integral part of the social structure, learning should enhance technological capabilities to enable students to adapt to the rapidly changing world. Students should therefore be taught how to think in order to function flexibly. A curriculum that emphasises social views of learning is recommended so that knowledge appropriation takes place in authentic contexts where it would be useful. A

research methodology underpinned by a socio-cultural theoretical framework is hence seen as appropriate in this study in order to promote the teachers' participation and their commitment to change.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Research is generally viewed as an ethical and empirical endeavour or a systematic investigation undertaken to address specific social issues, contributing and shaping knowledge by addressing specific gaps, replicating and expanding knowledge, broadening our perspectives and informing practice (Cohen, Manion, & Morrison, 2005; Cresswell, 2005; R. B. Johnson & Onwuegbuzie, 2004). Research processes and researchers are often guided by basic and commonly held belief systems or paradigms not only in choices of method but also in ontologically and epistemologically fundamental ways, leading to debate about rigour, validity and also hegemony on the nature and conduct of research (Denzin, Lincoln, & Giardina, 2006; Donmoyer, 2006; Guba & Lincoln, 2005). This study is no exception and is therefore shaped by the choice of the research methodology that guided the justification for the research design. This chapter presents the paradigm underpinning this research and outlines the selection of data collection techniques, sampling of schools and participating teachers, data analysis and ethical considerations.

3.2 Research Paradigm

There is a common understanding about the meaning of the word paradigm from Kuhn's (1970; 1962) *Structure of Scientific Revolutions* (Dillard, 2006; Guba & Yvonna, 1994; Lewis-Beck, Bryman, & Liao, 2004). A paradigm refers to a model or to an established system or way of doing things (Lewis-Beck, et al., 2004). Kuhn introduced the concept into the philosophy of science in his discussion of the nature of scientific progress and he focussed on practices of communities of scientists sharing their views of the nature of reality (ontology) and components that make it up, appropriate techniques for investigating reality and their epistemology and past scientific achievements. Thomas Kuhn argued that a paradigm is a prerequisite to perception itself, and what we see depends both on what we look at and also on what our previous visual conceptual

experience taught us to see (Lewis-Beck, et al., 2004). Guba and Lincoln (1994) narrowed down his definition and argued that a paradigm is “the basic belief system or world view that guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways” (p.105). It is therefore clear that a paradigm is a roadmap for researchers and according to Lewis-Beck et al., (2004),

...the process by which a scientist moves from working with the old paradigm to the new is analogous to a religious conversion; it involves not just adopting a fundamentally different way of viewing the world but also living in a different world (p. 786).

A researcher is therefore supposed to know the world he/she is operating in, in order to choose appropriate strategies and tools. However, the choice of paradigms has continued to be debated and activists of one paradigm view theirs as the ideal for research, so graduate research students are always torn between two worlds (R. B. Johnson & Onwuegbuzie, 2004; Labaree, 2003; Onwuegbuzie & Leech, 2005). The scholarship is essentially categorised by two communities of paradigm activists with one group in favour of positivistic inquiry and the other in favour of interpretive inquiry while an emerging community supports mixed methods.

The study adopted an interpretive paradigm and involved a mixed methods approaches (Cohen, et al., 2005; Cresswell, 2003; Donmoyer, 2006; R. B. Johnson & Onwuegbuzie, 2004; Onwuegbuzie & Leech, 2005) to capture a holistic picture of classroom and professional practices. An interpretive paradigm was chosen as the data was to be interpreted in the context of the students' and teachers' beliefs, experiences and their interaction with the school curriculum and the world they live in. The central endeavour in the interpretive paradigm is to understand the subjective world of human experiences and embraces the belief that human beings collectively construct social reality (Bishop, 1997; Cohen, et al., 2005; Lather, 1992). The focus is on interaction and negotiation through which people define expectations about appropriate behaviour. According to L.T. Smith (1998) an interpretive researcher seeks to understand values, beliefs and meanings of social phenomena, thereby obtaining in-depth understanding of cultural activities and the

subjective world of human experience. This study therefore included an in-depth understanding of pedagogical knowledge and practices in technical subjects where an intervention was situated in order to transform perceptions towards learning in technology.

3.3 Research Design

The study involved generation of both quantitative and qualitative data using in-depth interviews, focus group discussions, participant observations and a modified PATT questionnaire. The data were generated before, during and after a teacher professional development in order to observe existing practices and changes subsequent to the professional development. A case study approach (Cohen, et al., 2005; Merriam, 1998; Stake, 2003) was also adopted to observe effects of any interventions in real contexts. Stake (2003) argued that:

A case study is not a methodological choice but a choice of what is to be studied... We could study it analytically or holistically, entirely by repeated measures or hermeneutically, organically or culturally, and by mixed methods – but we concentrate, at least for the time being, on the case (p.134).

According to Merriam (1998) case studies “...are intensive descriptions and analyses of a single unit or bounded system such as an individual, programme, event, group, intervention, or community... do accommodate a variety of disciplinary perspectives” (p. 19). Merriam argued that case studies focus on the process, context and discovery rather than outcomes, a specific variable or confirmation.

3.4 Sampling Procedures

Non-probability sampling techniques (Cohen, et al., 2005) were adopted as the sample size was dependent on those willing to participate and also those who gave their informed consent. Two (2) urban schools and one rural school were involved in the study. The schools were chosen on the basis that they offer technical subjects and had at least two teachers in the technical education department. The schools were only those in and around Blantyre which included

Kabula, Mudi and Shire secondary schools. I visited the schools to verbally ask the principals for their schools' participation in the study. The principals who accepted to participate in the study were given the invitation letter for their official acceptance. After obtaining acceptance from three schools (see endorsements in Appendix 10) no further schools were approached.

With permission from the principals of the schools the researcher spoke with each Head of the Technical Education Department in each school for introduction and a briefing of the aims of the research. Once support from the heads of department was gained the researcher arranged for a meeting in each school with all the technical teachers. Each meeting involved an introductory briefing about the research, and initial negotiations for the teachers' participation in the study were undertaken. The researcher verbally asked for teacher participation before making more formal invitations to those teachers willing to participate. Only those teachers teaching senior classes were asked to take part in the study and two teachers from each school volunteered to participate in this study. None was coerced, but after the meeting, only those willing to take part were given invitation letters and their informed consent was also sought. Teachers' consent was also sought for the researcher to access their classrooms for lesson observation. The researcher also requested permission and consent from teachers and students alike to talk to the students while observing the teachers.

3.5 Sampled schools and their technology teachers

The study was undertaken in three case study schools: Kabula, Mudi and Shire secondary schools. Two teachers from each school were invited to participate in the study which included a professional development programme designed to enhance their perceptions about technology and technology education. The schools and the participating teachers' backgrounds are shown in Table 1 below. Pseudonyms for the schools and the teachers were used throughout the thesis. The schools' aliases present existing historical and physical structures well known in Malawi but not directly linked to the official names of the schools. The schools were also located in contexts suitable for teaching and learning technology in which teachers were unable to maximise the opportunities availed by their

location as a result of school culture and policy restrictions. This section will, therefore, discuss the case study schools.

Table 1: Background data of participating teachers

School	Teacher's name	Qualifications	Teaching experience	School background
Kabula	Zagwa	B.Sc. in technical education	8 years (Including 1 year as mathematics and science teacher at a private high school)	A-levels at Kamuzu Academy, and also studied design and technology in form 1
	Papysa	B.Sc. in technical education	3 years	MSCE (O-level)
Mudi	Mdzulo	B.Sc. in technical education	3 years	MSCE (O-level)
	Didi	B.Sc. in technical education and also studied mechanical engineering for 1 year.	2 years (including 1 year as a mathematics and science teacher at a school of his first appointment)	MSCE (O-level) and also studied school metalwork and technical drawing.
Shire	Chiipira	B.Sc. in technical education	2 years	MSCE (O-level). Completed JCE through distance education.
	Buli	Diploma in mechanical engineering	10 years (including 1 year as a mathematics and science teacher at a private secondary school)	MSCE (O-level). Studied school metalwork.

3.5.1 Kabula Secondary School

Kabula Secondary School is a national secondary school with a minimum capacity of 640 students. The school is situated in the city of Blantyre and shares boundaries with industrial areas and high density peri-urban townships. Residents in the townships engage in small-scale businesses. Furniture production, tinsmiths, welding and fabrication and bakeries form the major entrepreneurial activities of the townships.

Kabula is governed by the South Western Division, one of the country's six educational divisions. However, most decisions on training, recruitment and redeployment, curriculum development, financing and teacher wages and examinations are made centrally by the Ministry of Education and Vocational Training. A number of committees were set up to address various school needs and responsibilities. For instance the internal procurement committee (IPC) is responsible for all school procurement needs and makes decisions about the acquisition of resources for technical subjects. The heads of department are members of this committee. Kabula, as a grant aided secondary school, gets monthly subventions from the Ministry of Education and Vocational Training.

Unlike other schools, where technical sections are independent departments, the technical section at Kabula is part of the sciences department. As a consequence, some of the technical teachers have departmental responsibilities of teaching mathematics and physical science. When this study was conducted there were six technical teachers at Kabula. Two of them, Zagwa and Papsya (pseudonyms) who were both teaching senior classes, were involved in this study.

3.5.2 Mudi Secondary School

Mudi Secondary School is situated in the city of Blantyre and is also close to industrial areas, busy business centres, peri-urban townships and also residential areas with urban planned middle class housing. The school is therefore located in an area with multiple contexts in which learning of technology can be situated. Mudi enrolls a minimum of 960 students in forms one (year 9) to four (year 12) with six streams in each form and a minimum of 40 students in each stream. The students are streamed randomly. One of the streams, as a tradition, is assigned a

technical class and students choose to study technical subjects or home economics as options. As a result of social and cultural influences (Mammes, 2004), the tradition resulted in girls choosing home economics and boys, the technical subjects. For instance, at the time of this study, there were no girls enrolled in the technical strand.

Through the International Development Association (IDA) - a World Bank project - the government constructed five workshops at the school, two each for metalwork and woodwork and one for technical drawing. Technical subjects have been offered at this school since then. However according to the two teachers (Didi and Mdzulo) involved in this study, many developments occurred as a result of leadership with varying degrees of perceptions towards technical subjects, consequently leading to the closure of one of the wood workshops, later turned into a library.

Mudi was a grant aided secondary school and all revenues generated at the school were remitted into the government's consolidated account. The school was funded on a monthly basis from the Ministry of Education and Vocational Training and expenditure was deliberated and decided transparently by the internal procurement committee. The technical department was a fully-fledged department established after merging the technical and home economics sections. During this study, the section had four full time technical teachers with others also providing services in science and mathematics. Other teachers in the science department holding technical teaching qualifications also assisted in the technical section. So the departments for science and mathematics, and technical education shared staff and coexisted to cover tuition in science, mathematics, technical subjects and home economics.

Mudi was offering metalwork (MW) and woodwork (WW) in Forms 1 and 2 only and technical drawing was being offered in Forms 3 and 4. Students in the senior classes (Forms 3 and 4) were not offered opportunities to learn MW and WW because of scarcity of teaching and learning materials and due to electricity problems in the machine shops. These problems were still not resolved at the end of this study's fieldwork.

3.5.3 Shire Secondary School

Shire secondary school is situated in a rural area surrounded by tea estates. These estates have tea processing factories which could also provide rich contexts for teaching and learning technology related to tea processing such as plantation management, tea picking and blending, setting the scene for a range of technological issues and concepts.

The school was established in the 1940s to provide education for children of tea estate workers. As part of the wider curriculum diversification (Cartwright, 1990; Godwin, 1990) and with funding from the World Bank sponsored IDA project, the government constructed two workshops, one for metalwork and the other for woodwork. The school has been offering technical subjects since then and one of the teachers, Buli, was a technical student at this school.

The classes at this school were streamed into East (E), Middle (M) and West (W). Stream M is an all girls' class while W is an all boys' class. Stream E is the only mixed class and technical subjects and home economics are taken by students from this class only. Apparently all the girls at senior level had opted for home economics while all the boys were in technical subjects. The classes at this school were streamed in this manner as they attempted to understand whether streaming by sex would help enhance girls' performance in national examinations. According to the teachers, no improvement in girls' performance was observed as a result of the streaming. It was, however, shown that the best 10 students in O-Level examinations often came from the all boys' class – W, while the performance of girls in M and those in E was no different. Even though the research did not yield an improved girls' performance, streaming is a wide spread practice, such that students enrolled in form one, are randomly allocated to streams E, M and W. Each stream takes a minimum of 40 students and therefore the school's minimum student number was 480.

3.6 Data Generation

This study employed interviews, observations, reflective discussions that also included an intervention involving teachers in a professional development

programme and discussions of the PATT data. The sequence of data generation was as follows:

1. In-depth interviews with teachers before the professional development.
2. Classroom observation before the professional development
3. PATT questionnaire administration
4. Teacher professional development interspaced with classroom observations.
5. Classroom observation and reflective meetings after the professional development.
6. Interviews with teachers after the professional development.

3.6.1 Interviews with Teachers

Merriam (1998) argued that “Interviewing is necessary when we cannot observe behaviour, feelings, or how people interpret the world around them” (p. 72). The study engaged two teachers from each school in in-depth interviews in order to obtain teachers’ interpretations of technology and technological practices from their own point of view. Besides constructing the meaning of the teachers’ experiences, their voice is also critical as it gives them an opportunity to participate in change that affects their practices and beliefs (Bishop, 1997; Lather, 1992; Wenger, 1999). The interviews focussed on understanding the teachers’ existing classroom practices and their views towards technology and technology education. There were also a series of interview sessions before and after the professional development till saturation of the data. Techniques for ensuring credibility of naturalistic inquiry such as prolonged engagement, member checking, triangulation and debriefing (Cohen, et al., 2005) were implemented in order to generate authentic and valid data.

The interviews with teachers were semi-structured (Bishop, 1997; Merriam, 1998). Bishop argued that semi-structured interviews “...offer the opportunity to develop a reciprocal, dialogic relationship based on mutual trust, openness and engagement, in which self-disclosure, personal investment and equality is promoted” (pp. 32-33). Free interaction was promoted and there were

opportunities for clarification, discussion and probing of any emerging issues. As the discussions were flexible and more exploratory, rapport was established before the interviews. The interviews were audio-taped, with the teachers' permission.

3.6.2 Classroom Observation

Observation of participants in the context of a natural scene is a classic form of data generation in naturalistic inquiries (Hoepfl, 1997). Observations help to provide a deeper understanding of the context in which events, such as teaching and learning, occur. Hoepfl argued that observers should be skilled enough to be able to monitor verbal and nonverbal cues, use of concrete and unambiguous descriptive language in relaying both content and styles in which knowledge is acquired. As the presence of an observer introduces a distortion of the natural scene, efforts were made to minimize the effect. For purposes of legal and ethical responsibilities, the identity of the researcher and purposes of the study were revealed to students in a process of getting their informed consent to be observed.

The classroom observations were based on the principle of clinical supervision (Hopkins, 2002) where each observation was preceded by a teacher-researcher planning meeting and thereafter a reflection or feedback meeting. The planning meetings provided an opportunity to reflect on the proposed lesson and agree on aspects to be observed. According to Hopkins, a planning meeting also helps to build mutual trust and establish a non-threatening interaction climate. The role of the observer - that of observer as participant or non-participant observer (Merriam, 1998), was agreed upon with the teacher and each time the roles changed. In the feedback meeting, there was sharing of information gathered during the observation. Teachers' consent was also sought to access their classrooms for lesson observation. A checklist of what to observe (Merriam, 1998) was used during the observation. The checklist included physical setting, the participants, activities and interactions, conversation, subtle factors and researcher's behaviour.

Borich and Martin (2008) presented three methods of recording observation data. These included narrative reports, rating scales and classroom coding systems. This study adopted the narrative report as it is the least structured and provides a

comprehensive picture of the flow of classroom activities. While completing the checklist above, recording activities in the classroom involved production of narrative reports for each lesson using an ethnographic approach (Borich & Martin, 2008). According to Borich and Martin, “Ethnographic records report events sequentially, as they occur, without selecting a specific focus or incident” (p. 46). Other narrative approaches include anecdotal reports, thematic notes, and visual maps. The ethnographic approach has been preferred as it is flexible and allows recording to be done without making any judgements or interpretations. Besides the written account of the classroom activities, an audio recorder was used (with permission from the teacher and students). Although mechanical devices, by the nature of their obtrusiveness, are precluded for use in recording classroom observations, an audio recorded account assists during discussion, analysis and corroboration of the written account (Merriam, 1998; Wragg, 1999). Still pictures of specific instances were also taken to assist in the analysis. With the teachers’ consent, copies of annotated lesson plans and any teaching materials were made and originals were returned to the teachers. Copies or pictures of students’ work or artefacts made from this lesson or previous lessons were, where necessary, also gathered. Permission was also sought from the teachers and students to take pictures during the lesson. The pictures included any students’ work or teachers’ illustrations written on the chalkboard, and visual aids that were used during instruction.

3.6.3 Professional Development Programme

Six teachers took part in a professional development programme aimed at enhancing their understanding of technology and technology education. The workshop focussed on enhancing the teachers’ knowledge of the nature of technology, technological practice, technological concepts and processes, and general pedagogical knowledge - as these are central to effective teaching of technology (Moreland & Jones, 2000). The workshop took place in Blantyre-Malawi for a period of six days spread over three weeks (two days a week). The workshop was interspaced with teaching practice in order to give teachers time for reflection of workshop activities. Teachers had an opportunity to try out, in their classrooms, new ideas gained from the workshop. The sandwich arrangement therefore allowed the teachers immediate reflection-in-action (Loudwn, 1992).

Reflection, support and feedback (Bell & Gilbert, 1994), were found to be critical for effective teacher professional development. Classroom observations and interviews were hence done as a way of providing support and guidance to the teachers while trying out new ideas in their classrooms.

During the workshop each school made paper presentations based on articles assigned to each school. The teachers were required to read the articles and prepare for a presentation of an argument based on their reading. They were also given articles that were allocated to the other schools and also at least two articles for each session for their further reading.

As teacher professional learning occurs in a social context of practice (Timperley, Wilson, Barrar, & Fund, 2007) a range of activities was also structured to enhance teachers learning of the concepts of technology and technology education covered during the paper presentations. These included developing lesson models for technology and a visit to a shopping mall where they identified learning situations for technology. The teachers developed model technology units for their respective schools. Each school developed one unit and the teachers worked collaboratively in their school groups. However, the model units could not be implemented in their schools as their planned schemes of work for the whole term had already been ratified by their school administration structures.

3.6.4 Reflective Discussions

Researcher-teacher discussions were organised to enhance the teachers' reflections of professional knowledge gained and any change that may have arisen from the May/June 2008 professional development workshop. Literature has shown many ways of reflecting on one's professional knowledge; these are mostly influenced by adult learning theories (Banks et al., 2004; Loudwn, 1992; Osterman & Kottkamp, 1993; Williams, 2008). As reflection is a solitary and meditative process, Osterman and Kottkamp argued that "...analysis occurring in a collaborative and cooperative environment is likely to lead to greater learning." (p. 25). This is in contrast to Donald Schon's work on reflection which, was based on observation reports (Loudwn, 1992). Loudwn therefore suggests participative research occurring in the context of a well-developed collaborative relationship between teachers and researchers with action directly contributing to classroom

practices. Banks et al. (2004) developed a graphical framework called DEPTH, for understanding professional knowledge in technology education and it also drew upon Lave's (1991) situated learning in communities of practice. Although the framework was to provide teachers "...with a 'tool', a usable framework to help them consider aspects of their professional knowledge in the widest sense and grounded in their subject" (p142), the tool only assists in planning for professional development and does not necessarily apply to teachers reflecting while on practice. For instance in Australia (Williams, 2008), professional development participants used the model for school based collaborative discussions with technology teachers away from practice. However the model helped foster a community of learners as it provided reflection of technological knowledge and practices. L.S. Shulman and Shulman (2004) provided an account of work that looked at the challenge of creating education experience to help prepare teachers to develop a community of learners. According to L.S. Shulman and Shulman the 'community of learners' principle was defined in the 'Fostering a Community of Learners' (FCL) model which was scaled up, leading to the understanding of an accomplished teacher as someone who is ready, willing and able to reflect on experience. L.S. Shulman and Shulman's model supports the teachers becoming conscious of their own understanding, performance and dispositions. They pointed out that:

Through discussing their work - from curriculum design to classroom teaching and assessment - as well as developing teaching portfolios, writing cases and engaging in regular discussions of practice, we aim to enhance teachers' capacities to learn from their own and one another's experience. (p. 264)

Stein, Ginns, and McRobbie's (2007) model of professional development also focussed on enabling teachers to identify and critique one's own experiences, assumptions and beliefs and to understand, articulate and ultimately alter practice and social relationships. Their model included professional development experience that involved the teachers in a variety of theoretical, practical, and reflective experiences (Stein, et al., 2007). The teachers were collaboratively engaged in structured tasks covering both technology discipline and pedagogical knowledge.

Bell and Gilbert (1994) described three types of development for the teachers involved in their project. These included professional, personal and social development. Bell and Gilbert mentioned that the teachers in their study perceived greater benefits in working with other teachers and their professional development included classroom interactions. Both Bell and Gilbert (1994) and L.S. Shulman and Shulman (2004) agree on the centrality of reflection and collaboration for teacher learning and development. Williams (2008) also argued that opportunities for teachers to work collaboratively with peers in their project were essential to adopting new teaching practices. Omrod and Cole (1996) also found that:

...in-service activities are more effective in changing classroom practices when teachers themselves conduct the sessions, sharing their own experiences, demonstrating effective instructional strategies, and providing feedback and guidance... (p. 40).

Omrod and Cole (1996) argued that teachers - teaching - teachers model had justification in the social learning theories that people have high self-efficacy about their ability to perform a task when they see their peers performing it successfully. If they do not perform as satisfactory, the self-efficacy is lost and the expected collegial support vanishes into thin air.

Therefore, this study focussed on researcher-teacher collaboration since a working relationship was already established. However, it is recognised that technology is a social phenomenon and that there are social influences on change (Jones, 2003; Pavlova, 2005; Prislin & Wood, 2005). Therefore, the teachers in this study were supported in enhancing their capacities to reflect on their experiences for purposeful change towards building a community of learners of technology by sharing their work amongst themselves. The two teachers in each school should be able to work together towards creating an environment where new technology beliefs and interactions can thrive. A stimulating and supportive environment was also considered by Williams (2008) as one of the influential features for a successful professional development. Teachers in the Science Learning projects and Learning in Technology Education projects in New Zealand (Bell & Gilbert, 1994; Jones & Compton, 1998) were empowered by talking to each other about their classroom practices, providing their opinions for discussion and getting

feedback and reflections from peers. The participating teachers therefore opened up and shared materials and their professional development experiences with each other.

3.6.5 PATT Questionnaire

A PATT questionnaire (Bame, et al., 1993; Burns, 1990; Raat, et al., 1987) was adapted for the survey which targeted year 11 students in the selected secondary schools. This was the first time the PATT questionnaire has been used in Malawi on a large scale. This study was therefore an opportunity to contribute information towards technology curricula review that takes cognisance of learners' perceptions. The instrument was adapted to take into consideration Malawian culture, values and beliefs and the educational context. The questionnaire is shown in Appendix 9.

van Rensburg, Ankiewicz and Myburgh (1999) argued that the data from PATT questionnaire would not be as valid and reliable in Southern Africa as in monolingual, developed countries functioning in a technological society. The questionnaire yielded low variances which were attributed to terminology difficult for South African students to understand. The questions were also observed to contain directional statements some of which presented girls views more negatively than those of boys. The questionnaire tried in Malawi was modified taking into consideration the need for neutrality of the items and also cultural and linguistic barriers of the participants. The questionnaire was also compared with the PATT-USA which was also adapted in Hong Kong (Bame, et al., 1993; Boser, et al., 1998; Volk, et al., 2003). Final modifications of the questionnaire were informed by the results of the item-total correlation analysis of the pilot test.

All form 3 (year 11) students from Kabula, Mudi and Shire secondary schools were invited to complete the PATT questionnaire. A flier requesting their involvement was posted on the students' notice board. The students willing to participate were therefore informed in advance to assemble for the research questionnaire and those not willing did not avail themselves. An information or invitation letter explaining the research was given to the students before administering the questionnaire. The students had time to read the letter explaining the research and they were asked to give their consent by signing a

letter of consent before completing the questionnaire. Students were given two consent forms to sign. One form was collected by the researcher while the other form remained with the students for their own future reference. Those who chose not to participate after reading the research outline and/or the consent form were allowed to withdraw. The study targeted 120 students per school but only a total of 358 (191 males and 167 females) students completed the PATT questionnaire. At Shire, 142 students (75 males and 67 females) participated; 93 students (40 females and 53 males) were from Kabula; and 123 students (63 males and 60 females) were from Mudi.

The questionnaire was categorised into three parts. Part A had 15 questions on attributes of the students. The second part, B, was an attitude scale and included 60 questions structured using a five-point Likert scale from strongly agree to strongly disagree. The last part, C, was a concept scale and included 31 questions with the following options: agree, don't know and disagree. All the data were anonymously entered in SPSS and only descriptive statistics were used during discussions with teachers in each of the schools. The discussion focussed on the whole data set and was not specific to schools.

The purpose of the discussion over the PATT results was to help enhance the teachers' knowledge base about students' perceptions towards technology while also reflecting on the professional development programme. Perceptions directly influence classroom practices and subsequently learning in technological concepts and processes (Albarracin, Johnson, & Zanna, 2005; Jones, 1997). PATT Research (Raat, et al., 1987; van Rensburg, et al., 1999) influenced curriculum developments and added knowledge to educators' understanding about students' dispositions and how to shape them. The discussion therefore allowed the teachers to appreciate the students' perceptions towards technology to help them plan appropriate programmes or classroom activities. An understanding of the students' intuitive ideas of the nature of technology (Compton & France, 2007) may help teachers to situate learning in the students' own world. The PATT data was therefore used as a tool for enhancing technological classroom practices, unlike other research studies where it mostly informed technology education curriculum development and its implications (Burns, 1992; Raat, et al., 1985; Volk, et al., 2003).

3.7 Data analysis

The study involved the generation of both quantitative and qualitative data using questionnaires, in-depth interviews, participant and non-participant observations, focus group discussions and document analysis. The data generation processes were on-going with analyses undertaken at each level of the sequence in order to inform subsequent phases. All data collected using the PATT questionnaire were analysed using the Statistical Package for Social Scientists (SPSS) (Pallant, 2005).

Several data analysis techniques have been used with previous PATT studies. In the studies conducted in New Zealand, USA, RSA and Hong Kong, the analyses included principal component and factor analyses, reliability tests (Guttman and Cronbach alpha tests), and inferential and descriptive statistics (Boser, et al., 1998; Burns, 1992; van Rensburg, et al., 1999; Volk, et al., 2003). A factor analysis was used for both categorisation of the items into subscales and also as a way of confirming applicability of the categories generated in previous PATT studies. Both inferential and descriptive statistics were also used to analyse data generated from the PATT questionnaire.

The qualitative data were analysed using grounded theory (Merriam, 1998; Strauss & Corbin, 1998). According to Merriam (1998) grounded theory involves grouping data into segments or similar dimensions and the categories are compared to derive similarities and differences. The analysis seeks to establish patterns in the data and any relationship developed from such patterns builds into a theory grounded in the data. The data in this study was generated from individual interviews, focus group discussions, documents and artefacts from six case study schools. Cross-case analysis (Merriam, 1998) within and between schools was undertaken to explore relationships and patterns that emerged from the interactions with individual students and teachers in each of the three sampled schools.

3.8 Ethical Considerations

Ethics may be considered as the moral duty and obligation of researchers to protect the autonomy, integrity, beneficence and the rights and values of the researched and knowledge so generated (Cohen, et al., 2005; Howe & Dougherty,

1993; Howe & Moses, 1999; Payne, 2000; Weisberg, Krosnick, & Bowen, 1995). They are basically principles of general practice for the conduct of research to reduce or eliminate any grievous harm on research participants and the values and beliefs they represent. Ethics involves obtaining access and informed consent from the participants and providing guarantees of confidentiality, anonymity and non-traceability in the research. According to Cohen et al. (2005), informed consent involves the four elements: competence, voluntarism, full information and comprehension. Participants should be fully informed of the research and its consequences (costs or risks and benefits) and their participation not coerced. They should also have the right to withdraw at any point in the research process thereby protecting their autonomy (Howe & Moses, 1999). Howe and Moses also argued that ethics involves privacy which comprises anonymity and confidentiality and also includes human dignity and security for self or personhood. In education ethics should be followed to the letter because the violation of such may cause repercussions on children, parents and the school.

The research followed the University of Waikato Human Research Ethics Regulations 2000 and the ethical guidelines of the New Zealand Association for Research in Education. Authorisation to gain access to the schools, teachers and students was obtained from the Ministry of Education and Vocational Training in Malawi. An informed consent to participate in the study was sought from heads of schools, teachers and students. The ethics approval for this study was obtained in December, 2007.

Pseudonyms for the schools and the teachers were used throughout the thesis. However the names of the schools present existing historical and physical structures well known in Malawi but which may not directly link to the names of the schools. For instance, Kabula was the old name of Blantyre. Mudi and Shire are names of rivers. Mudi River cuts across the city of Blantyre. The river demarcates the industrial sites of Mudi and Makata and presents a context for technological problems to do with effluent from manufacturing industries beside other environmental and conservation factors of which students may undertake investigations. The Shire River connects Lake Malawi to the Zambezi River and it forms the crust of the Shire-Zambezi waterway, a technological development that would open landlocked Malawi to the sea. Dams at Nkula and Tedzani were also

developed on this river for hydro power generation that provides electricity for the whole country and, through an international grid, to parts of Mozambique and Zambia. It was therefore seen that Kabula, Mudi and Shire secondary schools were located in contexts suitable for teaching and learning technology.

3.9 Summary

This chapter presented a description of research paradigms, research design, sampling, data generation and analysis techniques and also ethical considerations that were implemented for the study. Sampled schools and their teachers were also described. An interpretive paradigm adopted for the study was discussed and the section also described the nature of data and also data analysis methods that included both deductive and inductive techniques. The results of the study are reported in Chapters Four, Five and Six.

CHAPTER FOUR

TEACHERS' EXISTING VIEWS AND PRACTICES

4.1 Introduction

Research has shown that perceptions influence both classroom practices and learning of technological concepts and processes (Stein, et al., 2007). This research involved interaction with teachers and their students from Malawi and investigated their perceptions towards technology and technology education. The focus of the study was to develop and broaden the teachers' ideas about technology and technology education. In order to build on teachers' existing ideas it was important to explore their existing views and teaching practices. This chapter presents the teachers' views, practices and corroborations resulting from school group discussions. Key findings will also be presented.

4.2 Teachers' existing views about technology and technology education

4.2.1 Introduction

The first part of the study involved in-depth, one-on-one interviews with the six teachers using the interview guide (see Appendix 8). The interviews took place in the teachers' respective schools and discussions aimed to identify teachers' existing understanding of technical education, technology and technology education. The discussions continued with a focus on differences between technical education and technology education. The issues that emerged during the discussions were organised into three themes: teachers' rationale of technical education, perceived limitations to implementing technical education and strategies to curb the limitations. The teachers' views are outlined below.

4.2.2 Teachers' rationale of technical education

This section reports on the views of the six teachers on the meaning of technical education, and whether it was important for students in secondary schools to study technical subjects. Teachers' views on the limitations impacting on the

implementation of technical education and strategies for addressing the limitations will also be discussed in this section.

4.2.2.1 *Teachers views on the meaning of technical education*

The teachers held similar views on the rationale of technical education as a learning area in general education. They viewed technical education as an important programme for students' after-school life, as it potentially opens up a plethora of opportunities. It was viewed as education that develops students' dexterity. The teachers asserted that the knowledge and skills or technical know-how acquired from learning technical subjects may help students in solving practical problems and to think more creatively.

...technical education means education given to students to solve problems technically. It gives them the technical know-how to solve problems with their own hands using available materials and equipment. (Didi)

...technical education is important because it is a multi-dimensional course or subject. It trains a person to be self-reliant, that is, a student is trained to be innovative. After completing technical education, students can easily articulate in the world of work, that is, a student can easily adapt to different industrial setups. (Mdzulo)

Technical education means vocational education as it is hands-on. In metalwork, woodwork and technical drawing, skills are imparted for students to make things, which can be seen and they can show. (Papsya)

Technical education means training students how to produce things using hands as well as the mind for poverty alleviation. (Chiipira)

The teachers viewed technical education as a tool for developing skills and technical know-how for making tangible things to solve problems. Mdzulo's views of the subjects' potential to enhance students' innovation, was limited to students being able to make new things. Mdzulo's view, about the students developing an ability to adapt to the demands of industrial tasks, supports the

curriculum framework as it considered technical education essential for promoting students' attitudes towards employment in technical or engineering related trades.

Technical education was also viewed by the teachers as instrumental in enhancing students' prospects and attitudes for self-employment and entrepreneurship that would lead to their own poverty alleviation.

It opens up somebody's mind. As they leave our schools, most of the students want or wish they can establish businesses but probably some still underrate themselves; they feel they don't have the capabilities. They leave school with all the technical know-how for self-reliance. (Zagwa)

...technical education skills may help students to be self-reliant... The students however should be supported with materials or equipment as starter packs to enable them stand on their own, to make things on their own. (Papsya)

I think it's necessary because with rising unemployment, technical skills will help them to become self-reliant or to easily get income through small scale production activities... Once the skill is imparted it's with that student; he or she will live with it. So it is necessary to teach technical skills for survival in the world. (Mdzulo)

It is very important to teach technical subjects...students acquire special skills; which can be used in their daily life. ...So most of these technical subjects can be applied in one's life. (Didi)

The teachers viewed technical education as important as it could lead directly to employment after school or at the least improve the students' ability to think laterally. Mdzulo commented that with the escalating unemployment in Malawi, the skills acquired in technical education would be helpful for students to engage in small scale production to earn a living as the skills also become part of their life. Didi also emphasised the skills were special and could be applied in one's life. None of the teachers doubted that the students could apply the technical skills to generate income later in life through small scale production businesses. However, Zagwa raised concerns about some students' lack of self-confidence to become self-reliant. He thought this may indicate gaps in students' disciplinary

knowledge. Self confidence highlights the level of disciplinary knowledge that the students acquire which may also influence their engagement in entrepreneurial activities as well as employment. In contrast Didi felt that there is a huge potential for students to become self-employed with the skills acquired in technical education at school.

Papsya mentioned that technical equipment was expensive and students may not be able to afford to purchase equipment suitable for production activities, making opportunities for self-employment unattainable. Papsya therefore suggested that it would be good to provide school leavers in technical education with starter packs to help them establish small scale businesses. However, the teachers also pointed out that the school programme may not adequately prepare the students for entrepreneurship, to take risks and survive the competitive nature of the open market as there were no study units and initiatives that would help instil an entrepreneurial attitude or mind-set.

The teachers assumed that technical education was beneficial for students later in life but they had little knowledge of students' occupations after leaving school, as most of the students were from remote rural districts of the southern region of Malawi, except for Mudi secondary school where students were selected from city primary schools. There was therefore little evidence regarding occupations of former technical students on whether they had established their own businesses such as production workshops. None of the schools seemed to follow up the career paths of technical graduates and the teachers remembered only few students who went to university to pursue various degree programmes including engineering. Buli, remembered only one technical student who ventured into a metal production business after school. This suggests that there is very little evidence that supports the teachers' notions about potential occupations their students might take up after leaving school.

Overall, the teachers viewed technical education as involving the development of skills for making things. The acquired knowledge and skills were also considered helpful to students in future jobs. Their views suggest an emphasis on the vocational nature of the technical education curriculum. However, their views also

showed the programme's potential to impart capabilities in design and problem solving essential for learning in technology education.

In the conversations the teachers also highlighted what they thought impacts on the realisation of the technical education programmes. Their views are discussed below.

4.2.2.2 *Perceived limitations to implementing technical education*

The teachers highlighted issues that impacted on the implementation of technical education in their schools. These included staffing, teaching and learning equipment and materials, and an outdated curriculum. The teachers said that their schools had sufficient numbers of trained technical teachers despite rampant shortages in the previous years. For instance, Kabula and Mudi secondary schools each had six qualified technical teachers, while Shire secondary school had three. Although the number of teachers in each school was sufficient for the schools to offer technical subjects at all levels, each school had their own unique staffing problems. Mdzulo mentioned the problem of teacher attrition arising from technical teachers leaving for jobs that offered better conditions of service. At Shire secondary school, staffing problems arose from previous practices where technical teachers were relocated to teach mathematics and science. With more science teachers at Shire secondary school, technical teachers were now concentrating on technical subjects. However, the redeployment of technical teachers into the science department was viewed as the main problem because science and mathematics, as core subjects, were perceived to take priority over technical subjects.

Despite having enough teachers, only Kabula secondary school was offering metalwork and woodwork at all levels while Mudi and Shire secondary schools were only offering technical drawing across the classes and metalwork and woodwork were being offered in the junior classes only. Apparently, Shire secondary school had no problems with teaching materials as the school provided for all their needs. However, they were not offering metalwork and woodwork in senior classes because of insufficient numbers of machines for student workshop practice.

At senior level, students learn lathe work, forging and shaping. The forge is not functioning and only two out of six lathes are working. It was not feasible for 12 students to practice, with just two machines. Besides, the lathe machines need to be serviced because, since 1999, there has been no machine maintenance. (Buli)

Besides problems of obsolete machines and insufficient working equipment and tools in all the schools, teaching and learning materials were also in short supply.

...there is a problem with teaching and learning materials...if you don't have materials, I think the skills won't be practical. You just teach the theoretical part of the skills while the students do not practice. Technical subjects are practical in nature and we can't just teach theory. (Mdzulo)

...the curriculum is the same old one but the facilities have deteriorated. In the past, schools had better facilities as the machines were in very good condition. They had adequate materials, for both teaching and learning. But today, we struggle to get the materials. (Zagwa)

I feel the teaching of technical subjects is nose diving. The school does not provide teaching and learning materials. Another problem, we don't have tools and equipment for teaching. In the workshop, there are no tools for students' use. Imagine two chisels for 15 students... (Papsya)

...So if you don't have materials, I think the skills won't be practical. We just teach the theoretical part of the skills and the students do not practise. When you are talking of technical subject, it has to be practical in nature and not theory. (Didi)

The teachers viewed technical education as involving practical experiences using machine tools and equipment. As a result of a lack of materials, machine tools and equipment, the teachers said that teaching was often reduced to the theory of materials and instrumentation. Technical subjects require consistent practice for meaningful learning and the schools were unable to offer this due to problems of teaching and learning materials. These issues were attributed to schools' lack of support and understanding towards the teaching and learning of technical subjects. However, teachers also felt that in the past the schools had been more supportive.

...most of the technical subjects are not given enough attention. In my school-days, the teacher could take us to the workshop to see things we were drawing and how they are applied in the workshop. Unlike today, our workshops have not been stocked and it is difficult to give examples - authentic examples. (Didi)

The teachers' views about teaching and learning resources were also reiterated later during focus group discussions in each of the schools. The teachers mentioned that the schools lacked support towards the provision of teaching and learning resources and the problem was seen as impacting on the teachers' pedagogical practices and students' learning of key skills. Due to the problems encountered, teachers resorted to teaching theory and science of materials and machining processes with little or no student practical activities. The teachers said that tools and equipment in the schools were not adequately replenished and there had been no maintenance of machines, rendering most of them obsolete and unusable.

Most of machines in metalwork are not in a good condition. So, we only use available machines for practical sessions at junior certificate level... In woodwork, unlike at Junior certificate when they are given already planed timber to mark and probably cut, at senior level, usually it requires that each candidate should have at least a plane, yet there is only one usable plane. (Buli)

... That is also one of the problems that we face. As a result, we give students very little practice. We just concentrate on theory because materials are not there and during exams, students do very well in the other areas but not in the practical exams. (Zagwa)

The teachers showed that the situation influenced them in making appropriate pedagogic decisions in light of the unavailability of resources. This also impacted on assessment practices as well as limiting the schools' decisions on subject allocation for classes. The teachers also mentioned the lack of instructional materials such as textbooks and teacher and learner guides and how they felt this impacted on their pedagogical practices. Developments in other subject areas

influenced the teachers to suggest the need for specific and locally developed student textbooks and also teacher and learner guides. Buli said:

I think some subjects, developed recently, have teacher and learner guides and technical subjects don't have... (Buli).

The guides for the other subjects were developed based on instruction and assessment organised in terms of behaviourist objectives with a forecast of perceived outcomes. The teachers suggested that the workshop should help initiate the process of developing similar guidelines for technical subjects as instructional materials which would also serve students' self-instructional needs. As the schools do not have enough books, the guides were seen as a possible solution to the problem. For instance, at Kabula secondary school the teachers indicated having a single old copy each for technical drawing, metalwork and woodwork. Hence, the students rely on teachers' notes and demonstrations with no other resources available for extra reading or practice – thereby hampering students' self-regulated learning efforts. The teachers also viewed the syllabus as too crude and without teacher guides they found it difficult to decide on suitable depth of content for the level of student understanding required.

The teachers also expressed dissatisfaction in the way the subject was implemented.

...It's like we do things routinely...I look at technical education as an area which would change somebody, especially the products-students – but I do not like the way we are handling the subject. We don't get the support we need. At the end of the day we just teach students to pass examinations. (Zagwa)

Current teaching practices were viewed as not helpful towards transforming students' way of life as they were not being exposed to thinking skills. It was believed that students were not engaged sufficiently to change their mind-set and think beyond the classroom and workshop activities as teaching focussed on examinations. Even the design and drawing projects were perceived as examination based which also stifled creativity as teachers focussed on students' passing examinations.

Overall it was seen that implementation of the technical curriculum was impacted by policy and the state of the curriculum. As the subject was optional it was difficult for administrators to source support and consequently they would rather use resources for core subjects. The curriculum was also viewed as old, with a focus on examinations rather than imparting thinking skills that would enable students to develop confidence and capabilities to solve problems. Consequently students' practical activities were viewed as limited due to lack of materials, equipment and tools and a supportive policy and environment for the teaching and learning of technical subjects.

The third theme that emerged from the interviews was about the teachers' views on strategies to overcome the above described problems which are discussed in the following section.

4.2.2.3 *Strategies to curb limitations impacting on the implementation of technical education*

The teachers identified a range of limitations impacting on technical education and its implementation which included, staffing, lack of support, obsolete facilities, lack of teaching and learning materials and services, and also an out-dated examinations oriented curriculum. The teachers made several suggestions to mitigate the problems that affect the teaching and learning of technical subjects. These included decentralisation of education administration and commercialisation of the technical departments, supervision and support from the Ministry of Education and Vocational Training headquarters, networking among teachers, a review of the curriculum framework and up-skilling in pedagogical practices.

The teachers expressed the view that the curriculum had remained the same over the years despite technological advancement and that the curriculum emphasised skills training at a time when facilities were dilapidated and with inadequate provision of teaching and learning materials. It was suggested that a review of the curriculum was needed to provide content that was responsive to global changes in technology and focus on students' thinking and their ability to solve problems. They also felt that a shift in pedagogical approaches was necessary to include projects and work based learning although implementation of such pedagogies

would entirely be dependent on their innovations and on the nature and level of the country's industrialisation and economic growth.

We are still equipping the students with some technical skills. They are able to understand ...how things are designed, how some mechanisms work...but I wanted us to be moving with the tide. What a technical student was able to do 10 years ago was supposed to be somehow different from what a technical student is doing today... (Zagwa)

Our syllabus has not been reviewed for a long, long time. I strongly feel there are some topics that are not really relevant at this level due to problems with equipment and probably their importance, I don't know, it's no longer useful. (Buli)

A review of the curriculum framework was proposed in order to get rid of units that may not be relevant. The teachers thought that such developments may help expose students to current knowledge and thinking other than focussing solely on skills which may not be useful after school.

It was also learnt that the Ministry of Education and Vocational Training attempted to establish craft design and technology (CDT) as a learning area, replacing the traditional technical subjects of metalwork, woodwork and technical drawing. Other than Buli, the other five teachers were, however, not familiar with the proposed CDT syllabus. The syllabuses were published in 2001, alongside other syllabuses, but Buli said they were unable to implement this because they lacked the underpinning teaching and learning guidelines. Buli said that teachers were not invited to participate in the development of the document but they were consulted regarding its implementation. The 2001 syllabus was viewed as emphasizing design and the making of artefacts and related theory. The participating schools did not have materials and knowledge to teach the new topics which included plastics, textiles and non-traditional materials such as cane, sisal, bamboo and clay.

The teachers viewed networking as central to a review process as it may provide a forum for negotiation towards meaningful reification of curriculum goals, theory and practices. Zagwa suggested the establishment of an association of technical

teachers that would provide support to teachers through in-service courses and networking, for sharing new skills and developments in technical education. Zagwa explained that:

Most teachers in the schools are inexperienced. They just have the knowledge they acquired from college. We have few out there who have the experience. So I thought we could have refresher courses, some meetings where we could share ideas to encourage one another. (Zagwa)

Zagwa's views fit international trends as associations created forums instrumental in curriculum reforms and development in many parts of the world. Although most of the associations are open to international membership, a local grouping of teachers and other technology professionals may also help support Zagwa's vision of sharing knowledge to improve learning in technology related subjects.

The teachers also suggested a change in teaching approaches to adopt pedagogical practices that allow students' active learning. The teachers felt that students needed more opportunities practising their skills.

...to be more effective, you need to involve the students during teaching. They should actively participate... In woodwork and metalwork; we needed to think of how we can now have the students do a lot of practice. The students need to be given more time to practise. (Papsya)

I think there is need to change the way we teach these subjects. The change should focus on teaching approaches. The focus is currently on examination. A work oriented approach would be more suitable. (Didi)

The teachers came up with a variety of ideas for practice opportunities in the classrooms. Papsya suggested workshop practice in woodwork and metalwork as a way of involving students. Didi proposed a project or work based approach that would focus on design projects where students would also be given an opportunity to interface with industry. Didi explained how he thought a work based approach would operate:

That could be done, especially if we were to give the students a lot of projects; take them into the industry to see what industry does, then come

back and they should be able to design and do some projects – a lot of projects in the learning. So the learning should be more in projects especially in metalwork and woodwork. (Didi)

The teachers also addressed issues concerning governance and finance. They considered a move towards decentralisation of the technical education departments so the departments can manage their own funding as a viable option. However, they acknowledged that such strategies also depended on policy support and guidance from the Ministry of Education and Vocational Training.

The teaching of technical subjects has many setbacks. Schools should devise a policy that would allow the technical section to generate income through production of various items for sale. The proceeds would be used for buying materials for further productions and for teaching and learning, paying utility bills and undertaking minor repairs and replenishment of machines and tools. (Papsya)

We could do more, only if we were mandated to use the workshop with the students. If I go into the workshop to prepare for teaching, my managers don't understand technical subjects and would think I want to make money when I actually want to give my students authentic projects. There is a lot of questioning... (Didi)

Commercialisation of the technical department was also seen as an opportunity that would provide entrepreneurship skills and apprenticeship for the students, allowing them to learn and practice doing authentic projects, which also supports suggested pedagogical approaches of work-based learning.

Teachers' views showed how central they perceive school and curriculum factors to be for any reforms of the technical education curriculum and therefore they felt reforms should consider the social and cultural context in which the curriculum will be implemented. As the subject was not a core learning area, the teachers were aware that it was difficult for schools to provide the needed support, as priority was mainly on core subjects such as mathematics, science and English which typically determine entry to university. The teachers appeared in favour of a curriculum model suiting local conditions and contexts to impart students in

Malawi with knowledge and capabilities in technology education which they felt could also help students better appreciate their own historical background, culture and the environment. The teachers' views suggest a shift from a curriculum emphasising routines and teacher led instructions to those promoting student active thinking.

In conclusion, the teachers' views suggested that they viewed technical education as mainly providing skills development for self-reliance and future employment and, as such, helping address poverty, youth unemployment and also providing skilled workers for industrial growth and development. They reported that these ideas shape their classroom practices so that students develop skills as demanded by the curriculum and to pass national examinations. However, the teachers also said that they struggled to implement the curriculum goals due to contextual, curriculum factors and an overarching policy framework. Governance and finance structures also impacted on the provision of support for teaching and learning as school leadership prioritised support for core learning areas. This was also compounded by the colonial and industrial nature of the curriculum which also demanded extra support and services for maintenance of machine tools and equipment which were currently scarcely provided. The teachers therefore, suggested a curriculum review and innovations related to effective organisational, pedagogical and classroom practices. The teachers' views showed that the curriculum implementation was shaped by contextual factors which needed consideration in the future if broad based technology education is to be established as a learning area in Malawi. However, any curriculum reforms in Malawi will be difficult unless the teachers' beliefs and policy assumptions focus more on educational ends. Further engagement of the teachers may also be required to help deepen their understanding of the meaning of technology and theoretical underpinnings of learning in technology.

4.2.3 The teachers' views about the meaning of technology

The teachers' views about the meaning of technology were explored and these will be presented in this section. Themes that emerged from the discussions included technology as designing and making things; solving problems and using

new things and hardware such as computers. The teachers' views will be presented below.

4.2.3.1 Technology as designing and making things

Technology was viewed as a process of designing and making of new things as well as repairing and maintaining artefacts. For instance, Zagwa said, "I would think it's a way of developing or designing things ... improving existing things". Papsya also said, "The word technology refers to the development of products and the improvement of those already existing". Mdzulo viewed technology as a process that involves change or transition between generations and referred to how various technologies during the early civilisation, were made, developed and transferred from one generation to another. Mdzulo highlighted the cultural-historical dimensions of technology.

4.2.3.2 Technology as solving problems

The teachers viewed technology as a process for solving problems. For example, two teachers, Buli and Chiipira, associated technology with the process of solving problems in a variety of situations including for example the environment. Buli associated technology with finding solutions to situations but the processes were restricted to craft activities. Chiipira also said: "... technology is about thinking of what is there in our environment and how to change it to suit our needs". An environment in this respect referred to people and how they interact with it. Hence, Chiipira viewed technology as dealing with environmental and ethical issues as well as a social phenomenon. Zagwa also associated technology with solving problems through the process of repairing things though he considered this to be a design process.

4.2.3.3 Technology as using new things or hardware

The teachers viewed technology as being about using new things or hardware. They also associated technology with modernity or advancement in life and how things are done and this was largely associated with the use of computers and new equipment.

... drawing boards were used for drafting but now we can use a computer. So that is technology; advancement from old activities to new ways of doing things. (Papsya)

Technology involves improvement in doing things. For example, in the computer age computers are used to improve efficiency in doing things. Even machines are driven by computer commands and software. So technology would be described as ways and means of improving the efficiency in doing work. But this has always been enhanced by the computer. (Didi)

The teachers viewed technology as a human activity and considered computers as pivotal in advancement and improving ways of doing work. However, Papsya said that computers were not always necessary in technology to improve conditions and used, as examples, the creation of new irrigation methods or new fishing techniques. Zagwa also viewed production of local toys such as those made from clay and also dancing robots, as technological activities that were being produced by children as examples where technology activities did not make use of a computer.

Teachers' reported views about technology as involving the use of things or hardware seem to have been influenced by their experiences in teaching technical subjects such as manual drafting and also by school and college training where they learnt computer aided drawing and design. Didi and Buli mentioned that they had experience with computers and numerically controlled machines during their mechanical engineering course while Zagwa learnt design and technology at high school.

Overall, the teachers viewed technology as a purposeful human activity to achieve desired ends. They made predominant reference to technology involving processes such as designing, making and also as hardware or things. Teachers valued technology for its potential for advancing and improving life. However, these were mainly associated with personal engagement and limited to the use of modern hardware such as computers and machines although they recognised other human activities also as technological. Their views provided a useful basis from

which to define aims and goals for teacher learning in technology by identifying the ideas they saw fundamental to technological processes and practices.

4.2.4 Teachers' understanding of technology education

The teachers' views about their understanding of technology education were explored during the interviews. Their views helped inform this study towards understanding their sub-cultural beliefs which involve the nature of the subject, suitable pedagogical approaches, the teacher's role and student outcomes. As the teachers viewed technology as new things and gadgets, they also associated technology education as skills training on how to design, produce and manipulate things or gadgets. The teachers' views are presented below.

4.2.4.1 Technology education as the science of materials and workshop processes

Only Zagwa, viewed technology education as involving teaching and learning about the science or theory and properties of engineering materials (for example, metal and wood) and about tools and equipment for production activities. He said:

You teach the basics such as properties of metal; why would I choose metal A and not metal B... why would I choose wood and not metal and what tools do I deploy (Zagwa).

Zagwa's view of what is taught in technology education seems just to involve teaching of science or theory of materials and workshop processes for making decisions about the choice of materials for production activities. Zagwa explained that:

...in technology, if one is designing a model of an artefact, one would be free to choose materials that would work best in the project. But currently the students' learning is restricted; if they are in metalwork they think of metal. (Zagwa)

The current technical curriculum was viewed as restricting students' learning and thinking based on the nature of materials used for production processes. He mentioned that technical subjects restricted students to a single type of engineering material, thereby hindering their creativity. His view was that with a

new learning area it would be possible to teach metal, wood, plastic and drawing as one subject. Consequently, Zagwa suggested a review of the curriculum in order to establish technology or design and technology as a learning area. The suggested learning area was viewed as a subject that would provide knowledge and capabilities to use all types of materials, processes and equipment depending on the activities the students were involved in.

4.2.4.2 Technology education as the training on how to use technology

The teachers associated technology education as training about how to use engineering materials, related tools and other gadgets such as computers and machines. For example, Didi and Mdzulo viewed technology education as teaching students how to use technology, but technology was seen as ‘new’ things and computers. Mdzulo said, “I would define technology education as the actual process of learning, teaching and learning about the aspect of technology.” Mdzulo mentioned that a computer is an example of technology and that technology education involves learning about computers.

In technology education ...in the information age, when computers are seen to be the new technology, I think teaching the students more about computers would mean that you are trying to do more of technology education... (Mdzulo)

Chiipira viewed technology education as involving learning beyond what is done in technical subjects as computers were also incorporated. Chiipira’s views seem to have been influenced by his own college experiences as he mentioned having learnt computer aided design in college and associated that with learning in technology education.

4.2.4.3 Teachers’ views about pedagogical approaches for teaching technology

The teachers’ views of technology also impacted on their views about pedagogical approaches for teaching technology. They viewed teaching in technology as involving design, solving societal problems and hands-on practical experiences. The teachers’ views are presented below.

Solving society problems

Chiipira viewed approaches for teaching and learning in technology education in a broader sense. He suggested a curriculum that responds to societal problems for learning to involve students in working out solutions to problems facing society.

...the curriculum has to answer the problems of the society. So I think the best approach would be to look at existing problems in society. Our curriculum has to respond and to provide solutions to problems that affect society. That is, our curriculum should enable students to find solutions to some of the problems in our society. (Chiipira)

Buli also viewed learning in technology education as equipping students with skills on how to solve problems but this only included repairs and also some production of new pieces of furniture.

Hands-on experiences

Two teachers, Mdzulo and Didi, viewed technology education as teaching practical processes involving hands-on experiences in using materials and equipment such as computers. As students' learning in technology education was reduced to learning how to use artefacts, availability of the materials and equipment or artefacts was considered essential for effective teaching and learning in technology education.

...There should be materials which will enhance learning in technology education. For example if you want to teach computer studies, there will be need for adequate computers for student to practice. Teaching should be hands-on for them to appreciate a computer as a technology. (Mdzulo)

An effective approach to teaching technology could be a hands-on-approach using actual artefacts of technology. Demonstrate to students and allow them practice. They would learn better in this way rather than just teaching them on the chalkboard through copying notes ... (Didi)

Technology education was viewed as learning about the science of materials. It was also considered as learning how to solve problems and they suggested design

and solving societal problems as pedagogical approaches for teaching technology. They also viewed the current curriculum as limiting students' creativity and a review was suggested to adopt technology or design and technology as a learning area. Although three of the teachers showed a slightly broad view of learning in technology, their understanding was still limited to viewing technology as things, design and making and hands-on training and this also influenced them in thinking of technology education as training about how to use technology or modern hardware.

Below is a further exploration on the differences between technical education and technology education which helped checking for consistency in the teachers' views about the nature of teaching and learning in these two areas.

4.2.5 The teachers' views about the differences between technical education and technology education

This section presents the teachers' views about the differences between technology education and technical education. The discussion was intended to solicit the teachers' views about what they thought was involved and whether that was consistent with their views about the meaning of technology education and technical education discussed earlier. When asked about the differences, only three teachers recognised some differences and one teacher was not sure whether or not there were any differences between technical education and technology education. The other two teachers viewed the two learning areas as similar.

I would think technical education is where you teach the technical know-how whereas in technology education ...you teach a skill that will entice a student to think more and do more on his or her own. (Zagwa)

I think there are differences. Technical education is about hands-on experience while technology involves thinking about what is available in our environment and deciding how to change it to address our needs. (Chiipira)

Technical education involves teaching hands-on work while technology education is education about technology such as computers. (Didi)

The teachers described the differences between technical education and technology education in terms of capabilities that students acquire. They associated technical education with hands-on experiences or technical know-how while technology was associated with thinking towards transfer of knowledge to varying situations such as manipulating the environment to address individual or societal needs.

Zagwa also thought that the teaching methods and styles in technical education can inhibit thinking, particularly in technical drawing. This subject was considered by Zagwa as more skills based. He suggested that there was a bit of thinking in metalwork and woodwork as students learn through projects which engage them in designing and making things.

...probably in woodwork and metalwork students are given a bit of chance to think. Students do projects and normally we give them a design problem and in most cases we even give them the design brief. They do their own investigation and they come up with their own solution. Somehow, there, we give them a chance to think and do something on their own but it's mostly craft based. (Zagwa)

Zagwa's views showed ideas concerning attempts at learning to use project and design based approaches although he thought of them as one concept. The approaches were viewed as significant towards enhancing students' thinking. In the discussion it appeared that for Zagwa, the benefits of the approaches towards enhancing collaborative learning were overshadowed by instructional strategies. It also appeared that instruction of the design processes was teacher-centred as the teacher identified the design situations and also provided the students with the design brief. It was also seen from Zagwa's view that learning in metalwork and woodwork was situated in craft activities where students were tasked to undertake workshop processes to realise their designs. However, the craft activities only focussed on making models such as chairs, cabinets, candle holders and many more products.

Only two teachers, Mdzulo and Papsya viewed both subjects as involving hands-on learning of skills and concepts for using advanced and modern equipment and for modifying those already existing.

There is no difference as they are all hands-on, though technology education involves drilling students to use advanced and modern tools and equipment. (Papsya)

...I don't see much differences between the two because in technical education we actually teach the concepts or the skills which the students can easily apply in the development of technology i.e. how they could modify an existing artefact, an already existing thing to suit a new environment... (Mdzulo)

Mdzulo did not view much difference between technical education and technology education since woodwork, metalwork and technical drawing were said to include aspects of technology and that the technical skills gained in metalwork or woodwork can assist in building technology. Technology was here viewed as things or hardware. Mdzulo hence viewed both areas as involving learning of skills for modifying or repairing existing artefacts or hardware.

Overall, the teachers viewed technical education and technology education as having differences and similarities but not as distinct areas of study. The teachers viewed both subjects as involving learning of skills for production of things using advanced tools and equipment and for modifying existing things otherwise referred to as repairing of things. On the differences, technical education was all about production skills development while technology education only involved teaching and learning about how to use technology such as computers. Only one teacher associated technology education with equipping students with capabilities to solve problems - and this was different from his previous view where technology education was viewed as teaching technical subjects using computers as in computer aided design. It was therefore seen that the teachers consistently maintained their assumptions about technical education but their views about technology education were somehow inconsistent as two teachers viewed it as also involving concepts of thinking and problem solving to address society's needs. The other teachers still maintained their limited views about technology education thereby associating it with learning about things, hardware and use of computers. However, the teachers' views about technology education as involving teaching students to think and solve problems and providing solutions that suits

the environment may be central towards creating an understanding from which learning in technology can be established.

4.2.6 Summary of the teachers' existing views about technical education, technology and technology education

The teachers viewed technical education as a programme that equips students with skills they could use to generate income when they left school. However, they had little knowledge about students' occupations after finishing their secondary education. The teachers also recognised that the teaching of technical subjects in their schools had not been without problems. They mentioned problems that impede the successful implementation of the goals of technical education and these included lack of teaching and learning materials, equipment and tools, obsolete machines, emphasis on examinations and an out-dated curriculum. Despite such problems, the teachers viewed the programme as essential towards enhancing the students' adaptability, attitudes towards engineering related trades, self-reliance, and employment thereby making the programme instrumental in supporting government's poverty alleviation initiatives. The teachers' assumptions of the programme were therefore driven by extrinsic reasoning and predominantly focussing on life after school rather than classroom based practices. However, there is not much evidence suggesting the merits of these assumptions. The programme was only able to attract a few students towards engineering studies.

In order to address the hurdles and to attain the programme's assumptions, they proposed a number of remedies and these included a curriculum review for learning that included thinking skills and also pedagogical approaches of problem solving, project and work-based learning. Although technical subjects were widely viewed as expensive, the teachers held strong beliefs about the assumptions of technical education which were also depicted in curriculum statements. However, the assumptions may not have considered educational factors and economic conditions of the world outside the classroom.

The teachers' views and assumptions about technical education also influenced their understanding of technology and technology education. They viewed technology as design, making things or advancement in the use of modern

hardware such as computers. Technology education was seen as learning about production, about hardware and about science of materials and processes. The teachers' views about technology and technology education were limited, even though they identified designing and solving problems as pedagogies in technology education. Only one teacher associated technology with environmental, ethical and social issues. The teachers' views about the differences between technical education and technology education were also consistent with their assumptions about technical education while two teachers viewed technology in a slightly broader sense, with the rest maintaining their limited views of technology education.

While the teachers held strong beliefs about the nature of technical education, pedagogical approaches and expected student outcomes, they also felt that there was a need to overhaul the curriculum to include thinking skills for students to be able to solve problems. Previous attempts to establish craft, design and technology as a learning area seem to have failed to influence the teachers' assumptions of a skills-based form of learning owing to their marginal involvement in the curriculum development processes and also their lack of broad knowledge of technology. Therefore, professional development that targets enhancing teachers' understanding of technology may help change perceptions, practices and beliefs to recognise technology education as a broader field than the current learning in technical education.

After these discussions with the teachers, they were also observed in their classrooms to get a better understanding of their practice informed theories about technology education. The following section presents the findings from the observations.

4.3 Teachers' existing teaching practices

4.3.1 Introduction

This section presents a description of the teachers' existing teaching practices generated through classroom observations for each of the six teachers. The observations provided a holistic view that helped to better understand the teaching environment, practices and how these were shaped by individual teachers'

perceptions towards technology and technology education. A narrative summary of each teacher's practices is presented in Appendices 1-6. The section below includes an overview of the observations, an analysis of the observations for each teacher and an overall summary of existing teaching practices.

4.3.2 Overview of observations

The classroom observations were conducted after the in-depth interviews (see Section 4.2) and before the teachers were involved in a professional development programme. The observations focussed on recording and analysing the teachers' classroom practices in order to understand the teacher's technological and pedagogical knowledge and practices. See Table 2 for a breakdown of the lessons that were observed.

Table 2: Observed lessons for each teacher

Name	Form	Subject	No. of students	No. of lessons	Unit observed
Zagwa	3	Metalwork Technical Drawing	1 10	1 1	Design Construction of foci, normal and tangents for ellipse and parabola.
Papsya	3 4	Woodwork Technical Drawing	3 4	2 1	Design Assembly drawing
Didi	3	Technical Drawing	8	2	Internal and external tangency, and loci
Mdzulo	4	Technical Drawing	8	2	Loci, junction pipes and freehand sketching
Buli	3	Technical Drawing	20	2	Construction of circles to satisfy given conditions
Chiipira	4	Technical Drawing	7	2	Construction of an octagon within a square, Archimedean spiral and development of cylinders

Ethnographic records of the events in the classrooms were taken and all the proceedings were audio recorded. Pictures of the teacher's chalkboard work, selected students' drawings and copies of design situations produced by the students were also collected and analysed. In addition to the observations,

document analysis was used to complement the analysis of the observed. For this reason, syllabuses for metalwork, woodwork and technical drawing and the approved schemes and records of work were collected and reviewed. In addition the drawing textbook by Morling (1988) was considered for analysis because all the teachers relied exclusively on this resource..

The nine lesson observations were preceded by one-on-one meetings to hear about their plans. Reflective discussions with the teachers followed some of the classroom observations. Reflective group discussions were also conducted with students after the observed lessons but only six after-class discussions took place due to students moving from one class to another. The following sections present findings from the observations for each of the teachers.

4.3.3 Zagwa's teaching practices

Zagwa, a qualified technical teacher at Kabula secondary school, was observed twice while teaching technical drawing and metalwork in a Form 3 class (See Appendix 1 for a narrative of Zagwa's lessons). Zagwa's lessons revealed essential features related to his existing teaching practices and his content knowledge. In both lessons Zagwa relied mostly on the schemes and records of work, textbooks and extensive use of the chalkboard. The schemes of work showed planned work for the two lessons and work for the whole term.

In the first lesson, Zagwa had one student and discussed the student's hanger design project as a follow up to the previous week's lesson about the design process. The brief for the project was identified by the teacher and the student was asked to come up with solutions in the form of sketches and their descriptions.

I discussed with him the whole design process. I also gave him a situation for design. I even gave him a brief for that particular problem. (Zagwa)

During the lesson, the student presented three design ideas which were basically the same idea but with minor modifications (see Figure 1). The teacher asked him to come up with different solutions to the brief. It appears the project was not in the student's context which may have influenced the learner to present an existing hanger in several shapes as design ideas.

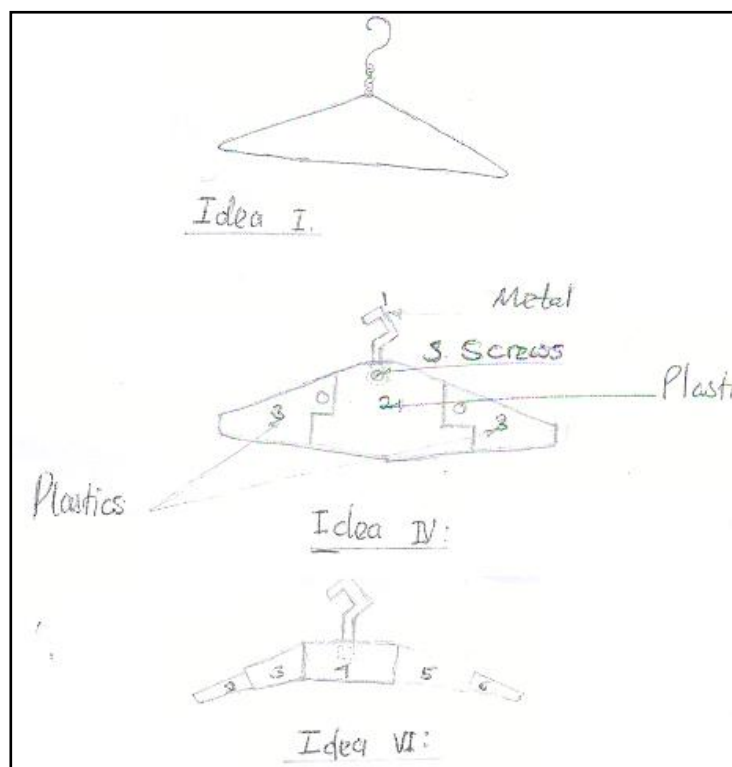


Figure 1: Design ideas by Zagwa's student

The lesson proceeded with teaching about production of working drawings for design even before the student completed the initial design processes. The teacher used an actual model (a v-block) and made sketches on the board to demonstrate the drawing process of assembly and detailed parts of a design component.

In the second lesson, Zagwa taught the process for constructing a focus, normal and a tangent. After interacting with the students on the previous topic, Zagwa made a formative decision to teach the construction of ellipses and parabola on which the foci and normal lines were to be constructed. Zagwa had already taught this topic in the previous lesson and through question-and-answer at the beginning of the lesson, the students had shown some understanding of such constructions. However, Zagwa revised this topic to deepen the student's understanding of the construction processes because such knowledge was considered as a prerequisite for the construction of foci, normal and tangent.

In both lessons, Zagwa used demonstrations to teach project work, design and construction problems from a textbook which also required that the students completed some as homework. Technical subjects require students' practical involvement but demonstration techniques were used throughout the lessons

which limited opportunities for the students to experience technological practices and learn from their own mistakes. Through the demonstrations, there were more drawings made on the chalkboard than what students produced on their drawing boards. Although this was a typical traditional apprenticeship style (S. D. Johnson, 1992) where the master craftsman models expert behaviour by demonstrating to the apprentice how to do a task, the students captured basic design knowledge. Zagwa attempted to implement project, design and problem-based learning as pedagogies that seek to support knowledge acquisition, critical thinking and problem-solving processes. However, he was unable to maximise the effectiveness of the pedagogies towards students taking control of their own learning processes with the teacher providing support and guidance. The v-block was an authentic example where the student may have practised making working drawings. This would have involved the student in the transferring of actual dimensions using an appropriate scale, drawing the v-block in pictorial or orthographic views. Zagwa's approaches to learning focussed on rote memorisation of construction procedures as opposed to learning, as a process for knowledge creation.

Though his classes were small in terms of student numbers (see Table 2), there was little interaction and support given to students during the two observed lessons. Some formative interactions were done informing the lessons' directions in areas that needed more emphasis. Zagwa also allowed the student to describe his design ideas, with the teacher asking questions at each proposed idea. Zagwa also reflected on his lessons and suggested remedies to address the gaps in his teaching methods. Zagwa would therefore benefit from a professional development that targeted pedagogies which promote students' active learning and use of meaningful contexts.

4.3.4 Papsya's teaching practices

Three classroom observations were conducted to gain some insight into Papsya's teaching practices. The observations included one technical drawing lesson and two lessons on woodwork design and drawing. The observation of Papsya's lessons (for the full narrative see Appendix 2) depicted his practices of teaching and learning technology. The lessons provided insight into Papsya's lesson

planning, assessment practices, pedagogical knowledge, subject knowledge and curriculum influences. The schemes of work and syllabuses were Papsya's main planning tools. Papsya also prepared a model answer for the assembly drawing which was extensively used during the first lesson but there were no written plans, notes nor textbooks for the design lessons.

In all three lessons, Papsya lectured and demonstrated his lessons and his interaction with students was minimal. Papsya revised test papers in the first lesson. In the second lesson he lectured the design process and only in the third lesson students were asked to critique their peers' design situations but none commented. There were some activities for students in all the lessons and these included redrawing the assembly questions and designing. In these two activities there were also attempts for formative assessment of the students' learning. In the first lesson the students were required to submit completed assembly drawings for grading but this may also have served as a motivation for the students to redo the question. The students were unable to complete the drawing during the test and immediately after revision, which suggests either a problem with the level of difficulty of the questions or else the learning targets were not fully attained. In the design lessons, formative assessments decisions were also made leading to Papsya's advice for students to improve their designs and he also gave them further examples of design situations (for instance the mop situation).

During the last lessons, it appeared that Papsya attempted to use design and project-based teaching approaches. He showed knowledge of a linear design process but his teaching approaches were more teacher-centred than engaging the students to actively learn the design process. For instance, the examples about a rat trap and a mop could have helped encourage interaction for students' learning through the practise with the design process by involving the students in exploring possible solutions and identifying their own situations right from scratch. Collaborative relationships between the teacher and students and among students was not emphasised for student's enhanced learning of the design process. The students' situations were also not broad as they focussed much on wood which may have limited their thinking about including other materials and technological concepts.

In his reflections Papsya stated that he felt restricted by the curriculum as the focus on examinations made it difficult to include applications and skills transfer for use of materials other than wood. The examination-based syllabuses also showed assessment targets of applications in wood only. Papsya would therefore benefit from a professional development programme that focuses on design pedagogies and also on assessment practices that promote students' thinking other than learning to pass examinations.

4.3.5 Didi's teaching practices

Didi, a technical teacher at Mudi secondary school, was observed twice in technical drawing with a class of eight students. The observations were preceded by planning meetings and there were also reflection meetings immediately after the observations.

Didi taught the two lessons by demonstration (see full narrative in Appendix 3). Following the reflections of his strategies in the first lesson, different teaching approaches were deployed for the second lesson leading to more student participation. The students were making their constructions on their drawing paper while he demonstrated on the board and by the end of his demonstration students had also completed their constructions. In recognition of the practical nature of the subject, Didi supported and coached the students to help them realise the set learning outcomes. He also included in his presentation students' experiences and familiar situations (children's games, a sewing machine, an electrician using a ladder, motor vehicle pistons/crankshafts) as examples to help students understand the concepts. However, most of the examples were from a drawing book. Interaction between teacher and students were observed in both lessons. The interactions focussed on formative assessment of students' progress during class exercises. He also used the chalkboard for students to draw parts of the constructions in all the lessons but in the second lesson he only used it creatively as only one student was asked to show how he completed his construction for the benefit of the other students who were unable to finish their drawings.

Didi did not prepare lesson notes or plans. However, during the delivery of the lessons, Didi's preparations were evident. For example he had made model

answers for the examples and he used the models extensively for both teaching and assessing students' progress. However, Didi's teaching practices exclusively focussed on transmission of knowledge and skills. Limited resources may have compelled him to deliver his lessons in this way since the students had no reference books for their further learning. They had new drawing equipment but without books, the resource kit was considered incomplete. However, as the teacher was, in this case, the only source of information, it limited the students' thinking and understanding of divergence in solving problems.

Overall, despite resources constraints, Didi's lessons showed practices that depict teaching and learning in technical subjects that focus on skills development. Didi had also shown his creativity and flexibility to change from transmission pedagogies to coaching and supporting student learning of the technical skills. A professional development programme should help Didi learn about instructional design and teaching and learning approaches that enhance technological practices through students' active learning.

4.3.6 Mdzulo's teaching practices

Mdzulo, a technical teacher from Mudi secondary school was observed twice before the professional development workshop and the lessons were in technical drawing. The observations (see the narrative in Appendix 4) revealed Mdzulo's planning and assessment practices, pedagogical and subject knowledge. In both lessons the focus was on examinations although the revisions aimed to prepare the students for learning in forthcoming topics. Mdzulo hence appeared to recognise transfer of knowledge for future learning. Besides the aim of the revision, he advised students that drawing skills would be useful in learning computer aided drawing. The assertion was, however, made as a way of motivating the students to learn drawing as the numbers of students enrolled in technical subjects were dwindling.

In both lessons Mdzulo used the drawing textbook throughout the presentations and also a test paper for revision. The content delivered in the first lesson showed the teacher's subject knowledge and confidence but there was need for thorough planning, creativity and innovation to be able to situate learning in contexts meaningful to students. For instance sketching and conventions taught in the

second lesson required different teaching approaches for students to develop capabilities for applying the skills and concepts in different topics and contexts.

In both lessons Mdzulo demonstrated on the chalkboard and asked some of the students to complete some tasks on the chalkboard. However, as a practical subject, the students did very little on their own drawing papers and they also just copied whatever was presented in both lessons. There were no opportunities in class for students to think about challenging situations and how to deal with unfamiliar situations in order to apply new knowledge. The approaches may have influenced students to develop dependency behaviour since the teacher was the only source of knowledge. Inadequate lesson preparation and gaps in technological pedagogical knowledge affected the delivery of Mdzulo's two lessons and he would benefit from a professional development that targets curriculum and instructional design and development.

4.3.7 Buli's teaching practices

Buli, a teacher at Shire secondary school was observed twice prior to the professional development. Both lessons were in technical drawing with a Form Three class of 20 students. The lessons were a continuation from the previous week's work about the construction of circles to satisfy given conditions.

The observation of Buli's two lessons (see the narrative in Appendix 5) revealed planning, assessment and reflective practices and also resource limitations, student interaction and his pedagogical knowledge. Buli exclusively relied on schemes and records of work which also covered work planned for the whole term. He also used a drawing textbook but there were no other sources of information for the students to access other than the teacher. During discussions before both lessons, Buli described his plans and executed them in the same depth as discussed which showed an understanding of the intent of all his lessons. However, his delivery of the lessons was hampered by inadequate teaching and learning resources. There were new drawing boards and A3 drawing paper but, besides a lack of reference drawing textbooks, the students also lacked basic drawing tools such as erasers, pencil sharpeners and appropriate drawing pencils. This affected the quality of the students' drawings and was also echoed in Buli's assessment and records of work.

Buli's assessment practices included a recap at the beginning of each lesson, class exercises and also homework. However, there wasn't much feedback to inform learning although he made some formative assessment decisions. For instance after noting that students did not complete their homework for the previous lesson, he decided to group them to discuss construction procedures but student's progress in the groups could not be seen and he abandoned the group work and decided to ask students to draw on the chalkboard. Buli interacted with the students in both lessons enabling him to make decisions as above. He supervised group work and posed questions although only volunteers attempted his questions and mostly these were invited to draw on the chalkboard.

Buli also articulated his pedagogical strategies. He explained his pedagogical plans during discussions prior to the lessons. He implemented the plans as discussed and his strategies included demonstration, discovery and group work and he actively involved students by asking them to work on the chalkboard. However, his implementation of the lessons showed some gaps in terms of knowledge and understanding of the pedagogies. For instance he relied on the demonstration techniques which also showed his belief in skills development delivered through expository methods of instruction. Also, there were no guidelines for group work and the content involved did not merit group work as there was not much need for students to work collaboratively or negotiate any desired outcome. A broad understanding of cooperative or collaborative learning strategies may have assisted in effective implementation of the selected techniques, along with how to organise lesson content reflecting such pedagogies. However, Buli was reflective and identified shortfalls in the first lesson which he attempted to change in the second lesson. He was also able to reflect on his own as shown in his schemes and records of work. A professional development programme that addresses pedagogy, active learning and instructional design might help to address these issues.

4.3.8 Chiipira's teaching practices

Chiipira, a technical teacher at Shire secondary school was observed twice before the professional development workshop. Both lessons were in technical drawing with a Form Four class. The observation of Chiipira's lessons (see a narrative in

Appendix 6) revealed his existing teaching practices in terms of lesson planning and development, resource utilisation, assessment, content knowledge, pedagogical knowledge, and abilities to reflect on one's own practice. In both lessons, Chiipira's lesson development showed some planning as the lessons were delivered in the order discussed during planning meetings. He relied on his schemes of work and a drawing textbook and also showed confidence of his subject knowledge. Both lessons focussed much on technical skills drilling. As a result, the students were not engaged in solving complex authentic problems as most constructions were all sourced from the drawing textbook. He attempted to use an authentic example for the exercise in the second lesson but teaching was all skills development that limited students' transfer of capabilities to authentic situations.

Chiipira also reflected on his teaching practices. For instance during discussions after the lessons he reflected on his way to involve students in using the chalkboard. He felt that this approach involved only a few students while the rest of the class remained onlookers. Chiipira also felt the need for enough knowledge about other techniques for student participation.

In the first lesson Chiipira demonstrated and involved students on the chalkboard while in the second lesson he interacted with the students by follow-ups and pauses that allowed him to check student progress in the constructions. Formative assessment interactions were observed but these were more conspicuous in the second lesson than in the first. For instance, in the first lesson he decided to demonstrate after observing the students weaknesses while in the second lesson he demonstrated with students completing constructions after him. However, no feedback was observed in the two lessons and as such, student learning was not reinforced. Chiipira would benefit from a professional development that targets pedagogical approaches and instructional design that considers learning beyond technical skills to broad based technological capabilities.

4.3.9 Summary of existing teaching practices

This section presents a summary of the practices as observed in the lessons taught by the six teachers. The summary will cover aspects depicted in the lessons

categorised into general pedagogical and technological practices. The description of each category is presented below.

4.3.9.1 Pedagogical practices

Instructional design and implementation

The observation of lessons in this study has shown the teachers' comprehension of the subject matter and pedagogical practices to teach content. The transformation of content into appropriate representation and instruction seemed to focus predominantly on teachers' activities and was less concerned with possible student interactions and associated learning outcomes. The teachers were all qualified technical teachers with teaching experiences ranging from one to ten years. Although all demonstrated some understanding of effective instructional strategies their teaching practices may have been shaped by social, emotional and cultural processes. As instructional planning for teachers is as important as a compass for a ship's captain, some form of planning was involved as they explained the purposes and expected outcomes of their lessons. The teachers had shown disciplinary knowledge as no subject errors were observed during instruction and they produced accurate drawings on the chalkboard. Models or teaching aids were also used by some of the teachers. However, detailed plans may have assisted in defining performance objectives, the nature of instruction, instructional sequence, instructional media and also learner characteristics and analysis of appropriate contexts in which to situate cognition. Four of the teachers prepared schemes of work and three teachers prepared teaching aids in a form of model answers and these were used extensively. Teacher demonstrations and students using the chalkboard as a way of participation were common methods among the teachers.

Two of the teachers, Buli and Chiipira from Shire secondary school employed aspects of active learning through group work but there were gaps in their understanding, planning and implementation of the techniques. More detailed planning may have increased teachers' critical thinking about the selection of tasks, teaching approaches and possible learning outcomes.

The teachers also evaluated and reflected on their teaching practices to enhance learning. For instance they revised previous tests and administered classroom exercises based on textbook problems. The students' exercises provided feedback to the teachers as shown in the evaluation remarks in some of their records of work. After reflecting on their teaching methods in the first lessons, the teachers changed their teaching techniques in subsequent lessons. Their preparedness to reflect on their practices was therefore important for any change towards adopting suitable instructional design and evaluation practices that emphasise formative interactions and the situated nature of learning in technology.

Classroom Interactions

The observation of the lessons delivered by the six teachers revealed minimal interactions in the classroom between the teachers and students. Instruction was teacher directed and focussed on lecturing and demonstration for skills development and the students' main activities were answering questions and copying constructions produced by teachers on the chalkboard. This was typical traditional instruction (De Miranda, 2004) as student participation, cooperation and peer learning were deemphasised. However, Buli and Chiipira were observed providing support and feedback during group work and also individualised classroom activities. Besides fostering the students higher order thinking skills and sharing of social problems and expertise, the collaborative activities assisted the teachers to monitor progress of the students in drawing the construction problems. However the group work was often not challenging and did not provide opportunities for students to think and discuss in a meaningful way. Complex tasks may help involve students in simultaneously interpreting, applying and evaluating given sets of instructions.

There were opportunities for interactions availed by the classroom situations but these were hardly optimised. Technical education is an optional subject. Students choose taking up this subject or not and this leads to varying class sizes. For instance, overall student/teacher ratio for technical subjects in the senior classes for the three schools was 10:1. Zagwa's class was the smallest with only one student, reducing it to individualised instructions, which offered a variety of teaching and learning styles to maximise interaction. Only Buli's class had 20

students. Small student numbers would have provided opportunities for personalised instruction, scaffolding and discussions so that all students contribute ideas during the course of instruction.

Teachers were restricted by limited resources, the nature of the curriculum and the emphasis on external examinations. This resulted in a strong focus on content delivery without much consideration given to activities that would engage the students conceptually or deepen their practices on newly introduced skills. For instance, the students had no textbooks and other basic drawing tools and equipment as schools were only supplied with new drawing boards and A3 paper. Teachers made extensive use of textbook problems that stifled the teachers' innovation and creativity for authentic assessment which may have enhanced learning, using locally available materials and any recyclables within and outside the school. As they held limited general pedagogical knowledge, the teachers in this study might benefit from a professional development that enhances their skills in instructional design which takes into consideration interactive and collaborative learning of technological processes.

4.3.9.2 Technological practices

The observations of the lessons presented by the six teachers revealed some classroom activities related to technological practices although the teaching was mostly limited to drilling and theoretical development of technical skills. Technological practices revolve around solving authentic problems that address societal, environmental and cultural-historical concerns. The observations revealed the teachers attempted to develop the students' technological practices through design projects, graphical communication and problem solving. The practices are described below.

Problem solving

The students were involved in problem solving activities related to skills in graphics and also design projects. In graphics the teachers gave students construction problems such as the electrician's ladder problem and a simple link mechanism in Didi's lesson, Buli's container for fitting drums and Chiipira's jug for use in refugee camps. The nature of the problems presented opportunities for

students to engage in critical thinking to understand issues beyond the drawing constructions. However, the problems did not seem authentic as they were all just picked from a drawing textbook, although the problems contained interpretive or contextual materials that ought to help enhance the student's understanding of the situations. Consequently the students had little opportunity to critique and reflect on their own technological practices. Actual interactions in practice either in class, school workshop or in an industrial setting may help consolidate learning and develop technological capabilities based on real life contexts. Buli's application in the second lesson, for example, focussed on industrial design and drafting activities and students could have conceptualised the design problem in an actual setting. The teachers all had opportunities for meaningful contextualisation of learning but failed to use them. Specifically, the teachers seemed to lack deep knowledge and understanding of technological practices in order to design instruction that incorporates problem solving situated in real-life contexts. In all the problems the teachers used they focussed on advanced knowledge of graphics and curriculum skills and knowledge preparation for examinations.

Graphical communication

Each of the six teachers had one or two lessons in which graphics, also known as technical drawing, was taught. Essential infrastructure for teaching manual drawing was available as observed in all the lessons and students often lacked basic tools and textbooks. The teachers exclusively used one textbook, but had no student texts available, leaving teachers as the only source of information. New drawing equipment was provided in all the three schools but the support was not extended to other basic necessities for the schools' effective teaching and learning of technical subjects like metalwork and woodwork. Despite a lack of basic learning materials, the teachers had sufficient content knowledge for teaching manual drawing skills but they seemed to have limited pedagogical knowledge for teaching the subject. In all the observations, lecturing and demonstration were common methods and students were also involved in drawing constructions on the chalkboard. The teachers were satisfied with the techniques used for teaching drawing. Only Chiipira expressed scepticism over the effectiveness of using students to make constructions on the chalkboard during instruction and whether there was any other appropriate and effective pedagogy for involving students in

learning graphics. The teachers reflected on their techniques but Chiipira moved a step further by changing his methodology to include student drawing practice, coaching, supervision and support of student classroom exercises.

The teachers in this study recognised the importance of graphics in design and the learning of computer aided drawing. Learning in manual drawing, including sketching, was associated with enhanced understanding of computer aided drawing and sketching was also linked to the designing process. The lessons also included applications related to industrial drafting and design which included production of working drawings for design planning and development. However, despite the teachers' graphics content knowledge, their limited pedagogical knowledge and practices affected the teaching of drawing and design as technological processes and practices.

Design processes

Designing as a technological activity was a major focus in the lessons taught by the teachers. Two teachers, Zagwa and Papsya, both from Kabula secondary school, taught design as a topic under metalwork and woodwork, while the other teachers taught graphics and recognised the subject as an essential component for both design learning and practices. Teachers from Mudi secondary school and Shire secondary schools did not teach design because their schools were not offering metalwork and woodwork and the technical drawing syllabus did not incorporate design as a topic.

The syllabuses did not provide adequate guidelines for the design process and included project based learning as the only pedagogical approach. Although the absence of guidelines gave the teachers flexibility, it was noted that Zagwa and Papsya followed a linear, systematic process that included problem identification - design brief – ideas – investigation – planning – making - evaluation. Even though their design approaches seemed similar, their pedagogical styles for initiating design ideas were fundamentally different. Zagwa provided the design situation and a brief for the student to proceed with the other steps, while Papsya asked students to undertake the entire process by identifying their own problems based on their life experiences. Zagwa's style did not expose the student to more thinking and exploration of own technological experiences. Zagwa's methodology

characterised design as a linear process leading to singular and predictable solutions to problems. Papsya attempted to drill the full design process without allowing students to explore and understand the individual design steps leading to low creativity in their design situations and proposed solutions. However, both teachers precluded the social dimensions of the designing process as they focussed on individualised processes. A consideration of how teamwork and collaborative learning situations can support students in tackling design problems may have helped with the students' learning of the design processes. The design processes were limited to the design-make-appraise concept and there was no consideration of societal, environmental, ethical and other cultural-historical values of the processes and products. The students' investigations also focussed on materials such as wood and metal which limited their creativity and scope of their design ideas. The packaging of the curriculum therefore influenced the nature of design processes and practices adopted by the teachers as design was only incorporated as a unit in metalwork and woodwork where emphasis is on production skills. Hence, an understanding of technological knowledge is essential in assisting teachers to streamline and synchronise practices involved in design-make-appraise processes, metalwork, woodwork and technical drawing to establish a learning area that emphasises the enhancement of students' technological capabilities.

4.3.10 Corroboration of classroom observations

The classroom practices reported above were triangulated and corroborated in focus group discussions that took place in the three schools and one which took place on the first day of the professional development workshop. The discussions focussed on the current teaching practices and influences on such practices. It was shown that the teachers held behaviourist conceptions of teaching and learning technical subjects and this seemed to be influenced by their pre-service teacher training and other factors surrounding the provision of support for teaching and learning resources. They appeared to hold deep beliefs about the assumptions for teaching and learning technical subjects although there also seemed to be shortfalls in their disciplinary knowledge. This section will report on the discussion, in particular the teachers' views about teaching and learning technical subjects, teaching and learning resources, technical and pedagogical knowledge as

these emerged as critical issues during both group discussions in the schools and also during the teacher meetings which were organised after every classroom observation.

4.3.10.1 Teaching and learning technical subjects

During the meeting in the schools, the teachers discussed their pedagogical practices and often showed a preference for teacher centred strategies of transmission of knowledge and minimal facilitation of student learning. This impression was supported when teachers referred to lecture methods and demonstration of skills while pedagogies that seek to promote constructivist styles of active learning, like collaborative learning or use of authentic contexts for example, were not given much prominence. The few student activities mentioned however, also seemed to require less thinking and reasoning as the emphasis was on craft and skills development. Below is a presentation of the teachers' existing conceptions of the pedagogical approaches and also illustrations of the teaching processes with examples about how they could plan a lesson for a topic chosen for this discussion.

Pedagogical approaches

A discussion of the methods of teaching technical subjects revealed the teachers' beliefs about teaching and learning, which also seemed consistent with their teaching practises reported in this chapter. They viewed teaching of technical subjects as involving transmission of craft knowledge and skills through lecturing on the science of materials, the theory of processes and the demonstration of production operations.

... We have theory, in which we discuss with the students processes, terms... parts, uses and functions of tools and machines... A lot of demonstration is involved, investigations and discussions. In woodwork or metalwork, there is a part of 'do-it-yourself' so that... we find out whether the lesson or demonstration has achieved anything. (Zagwa)

...it's more of theory... followed by a hands-on activity; they need to do it and practise which also helps to know whether the imparted skills have indeed been assimilated... (Papsya)

The teachers' viewed pedagogical practices in technical education as involving student thinking and application of concepts and as practising of the theories covered during lectures. Depending on the nature of the topic, practical activities were viewed as useful for student learning as well as for the assessment of students' progress. Students' involvement in lessons was also recognised as instrumental towards their learning although the common form of involvement included inviting students to create illustrations on the chalkboard.

Group work was also considered as another method of teaching technical subjects but they struggled to identify ways of facilitating collaborative and cooperative learning. For instance student discussion was seen as unattainable since they doubted students' abilities to discuss unfamiliar matters, yet group work engages students in a discussion of some sort. That view seemed to show their belief that students come to class with little or no knowledge thereby justifying the use of transmission styles of teaching. However, only one teacher later argued that the structure of tasks in group work may influence the nature of discussions and it was viewed as a possible means of engaging students to share knowledge and skills. The teachers' conceptions of teaching and learning were also revealed through illustrations of teaching processes discussed below.

Illustrations of teaching processes

In order to describe some of the teaching and learning processes in context, the teachers explained how, for example, freehand sketching could be taught. Freehand sketching is a topic in technical drawing where students learn how to produce rough preliminary drawings or sketches to help their understanding of configurations of objects or design ideas (Bertoline, 2002; Boundy, 2002). The teachers explained their views by describing the teaching process of freehand sketching in general terms.

In sketching, we start by introducing the pictorial projections... We do teach them how to draw lines free-hand. For example when drawing

curves the hand is supposed to be inside the curve... For sketching in orthographic drawing, they use the same principles of drawing straight lines... so many of the skills of sketching are taught when introducing the projections. (Zagwa)

It appears freehand sketching was not seen as a standalone topic as it was shown as integrated in pictorial and orthographic projections which may have influenced the teachers' views about pedagogical styles for delivering the content. It was therefore seen that the planned teaching processes seemed to focus much on teacher activities with little or no student coaching and support towards learning of sketching skills and practices. Teachers from Shire secondary school had planned some student activities such as sketching of real objects and also copying drawings demonstrated by the teacher on the chalkboard.

In sketching, we demonstrate how to produce parallel lines freehand and how they can handle the pencils to produce a straight line. After demonstration, we can let them probably draw likewise on paper to produce parallel lines, lines at an angle, at different angles and thereafter we can bring them real objects; objects that they see right in the workshop... (Buli)

Student activities in this illustration were included and seemed to incorporate aspects that would challenge student thinking and reasoning although this just involved changing angles of lines. The illustrations also showed attempts to include life situations but these only referred to objects that were often teaching and learning models which may not have represented authentic contexts – where the knowledge would be useful. The teachers therefore needed to know about the practical value and processes of sketching from which they would situate learning contexts meaningful to student needs and experiences. As Buli viewed sketching as having less emphasis in drawing, he chose another topic to explain the teaching processes. He explained the process of teaching riveting; a topic in metalwork where students learn the skills related to mechanical fastening of metals to form permanent or semi-permanent joints.

On riveting, we begin with question-and-answer on what they know about riveting from their home experiences and probably situations where they

have seen rivets in use. Then we discuss materials for producing the rivets. Then, after showing them riveting equipment, we discuss riveting procedures by giving them books to discover the procedure that should be followed or we can just lecture the procedures. After the procedures, then we discuss faults that may arise if some of the processes have not been followed. After discussing the faults and solutions then we demonstrate the riveting process using available equipment. Thereafter, we give them pieces to practise. (Buli)

The teachers' examples showed their conceptions of learning as constituting the acquisition of facts and operational procedures. Transmission styles of teaching were hence their key pedagogical techniques to achieve such goals. The two examples also showed more teacher activities, and the few students' activities that were planned also seemed restricted more to skills and craft practice in the workshops. The teachers seemed to have insufficient knowledge of pedagogical approaches suitable for teaching practical subjects as they overly relied on general teaching methods. There were attempts to contextualise learning and they also attempted to incorporate student's experiences but they seemed to lack creativity to situate learning in authentic and relevant contexts.

The teachers' pedagogical knowledge was attributed to the nature of their pre-service teacher training as they mentioned their college training only involved general methods of teaching and not those appropriate to teaching technical subjects. Only two teachers seemed to recognise approaches that may promote constructivist learning in technical subjects. However, the two teachers' pedagogical knowledge seemed limited and restricted to non-challenging student tasks with little student engagement in active learning. It also seemed the teachers' choice of pedagogical styles was also influenced by the limitations arising from a lack of resources. The resource limitations are described in the section below.

4.3.10.2 Technical and content knowledge

Both discussions (school groups and workshop group discussion) revealed that teachers lacked technical and content knowledge related to machine maintenance and they also lacked skills to operate some of the machines such as lathes and

shapers. The teachers said that they had not learnt such skills when they were at college and some had learnt them on the job. The teachers attributed this problem to their limited experience with and pedagogical practice related to machining processes during their pre-service training. The teachers suggested a review of teacher training programmes to include more technical pedagogy, machine maintenance, industrial experience, and enough teaching practice exposure.

Student teachers need a vigorous approach to technical subjects. They should be given more time to practice the technical skills in woodwork, fabrication and welding, metalwork and plastics (Mdzulo)

They should be attached to factories, industry for a real production environment and practices... With knowledge of production from industry plus skills learnt in college, they will teach the student real things (Didi)

The teachers' views seemed to suggest work-based learning as a suitable approach that may help instil confidence, enhance teacher trainees' content knowledge and build practical experiences. However, the concept also depends on the nature, size and willingness of industries to absorb the trainees and the type of skills the trainees may be required to develop which would be relevant to a classroom situation. While the concept was viewed as appropriate for teacher training, they did not see it as suitable for school students' meaningful learning of technical subjects. Their views may have been influenced by their beliefs in traditional instructional approaches as they also believed in teachers amassing more disciplinary knowledge – as they expected students to be passive learners. The teachers' quest for more technical knowledge to maintain and operate machines also reinforced such beliefs. However, the teachers had shown some understanding of the need of pedagogical knowledge to be able to creatively incorporate authentic learning contexts in their instructional plans. A shift in their beliefs towards pedagogies that promote constructivist learning styles was critical in enhancing their teaching practices and also how they perceive technology and technology education.

4.4 Summary of teachers' existing views and practices

Teachers' existing views and practices were generated through one-on-one interviews, classroom observations and group discussions. The discussions focussed on the teachers understanding of the meaning of technical education and about the nature of technology and technology education. The teachers' technological pedagogical practices were the focus of the classroom observations and, through teacher meetings, there was more understanding and rapport over their teaching plans. The discussions helped develop a better understanding of the influences impacting on the teachers' pedagogical practices. Such insights helped further identify the influences of the vocationalised curriculum and how this may affect the promotion of teaching and learning for student technological literacy as espoused in Malawi's Vision 2020 and the Science and Technology Policy for Malawi. Engaging with teachers therefore helped understand their implicit beliefs and theories surrounding their teaching practices and how that impacts on curriculum reforms.

After a cross-case analysis of the six cases, corroborated with the focus group discussions, four key findings emerged. These were:

- Teachers held beliefs that technical education offered skills development for jobs and self-employment.
- Teachers had limited knowledge of the nature of technology and technology education
- Teachers had general pedagogical knowledge with limited instructional design practices and limited technological pedagogical knowledge.
- Teachers held broad technical education content knowledge for skills development but their technological knowledge and practices were limited.

Although technical subjects are widely viewed as expensive, the teachers held strong beliefs about the goals and benefits of technical education. They also viewed the programme as essential to enhancing students' adaptability and developing positive attitudes towards engineering related trades. The teachers'

views suggest an emphasis on the vocational nature of the curriculum as they considered the acquired knowledge and skills helpful to students in future jobs. However, the teachers' assumptions of the programme were also embedded in the curriculum and all policy guidelines leading to the introduction and implementation of technical education also emphasised the country's need for skills development for entrepreneurship and jobs in industry and government. However, there was no empirical evaluation of the attainment of the programme's goals and assumptions. The discussions with the teachers showed that career paths of technical graduates were hardly ever traced as the teachers could only remember a handful of students who were selected to pursue various university programmes. They viewed school culture and curriculum factors as impacting on implementation of technical education leading to teaching practices that hardly gave students any exposure to thinking skills. In order to attain the desired goals, the teachers suggested innovations related to effective organisational, pedagogical and classroom practices. Despite their beliefs and values, the teachers were aware of knowledge gaps resulting from internal as well as external obstacles which appeared as an opportunity and a challenge towards any initiatives for change in educational practices and their own continued learning of emerging theories and concepts in technology education.

Teachers also perceived school and curriculum factors as central for any reforms of the technical education curriculum. Therefore, they felt reforms should consider the social and cultural context in which the curriculum will be implemented. As the subject was not a core learning area, it was difficult for schools to provide the needed support, as priority was on core subjects such as mathematics, science and English which typically determined entry to university. The teachers suggested a shift from a curriculum emphasising routines and teacher led instructions to one promoting student active thinking - which they saw as a step towards repositioning the subject among core learning areas.

The teachers were interviewed on their understanding about the nature of technology and technology education. It was reported that the teachers had limited knowledge of technology and technology education. They viewed technology as purposeful human activity associated with processes such as designing and making things, solving problems and using new and advanced things or hardware

like computers and machines. The teachers also viewed technology education as learning about the science of materials and processes and as training on how to use technology or hardware.

While the teachers' views were shaped by their expectations and beliefs about the nature of the technical curriculum and what they perceived students may gain from such learning, they also recognised the need to reform their practices by also adopting new pedagogical approaches. Some of the suggested approaches included incorporating, for example, problem solving, projects and design into the syllabuses but the teachers' knowledge of underpinning theories for such pedagogies appeared limited and they were also restricted by conditions set by the national examinations system. Other approaches suggested by the teachers included, for example, work-based learning, which is a concept similar to cognitive apprenticeship and learning in communities of practice. Therefore, the teachers do in fact hold some of the basic views of teaching and learning approaches that are also fundamental to the teaching and learning of technology.

The classroom observations reported previously showed that the teachers in the three schools held general pedagogical knowledge but limited instructional design practices and also limited technological pedagogical knowledge. There was no systematic design of instruction and assessment procedures, which made it difficult for them to effectively organise classroom events essential for learners' construction of technological knowledge. The teachers also showed limited understanding of appropriate methodologies for teaching and learning technology. They employed design, problem-solving, project-based learning and collaborative classroom activities but the processes lacked support and social mediation for effective learning. The teachers' pedagogical and lesson organizational practices showed gaps in terms of their understanding of the classroom as a social organisation and related concepts and principles of effective instruction in technology education. Instruction was predominantly expository, teacher centred and included minimal student activities which were seldom contextualised. The teachers would therefore benefit from a professional development programme that targets their understanding of technology as a social phenomenon and the fact that social-cultural perspectives of learning play a critical role in students developing technological capabilities.

The classroom observations revealed broad technical content knowledge but technological practices were restricted to production techniques, design-make-appraise concept and manual graphics. The teachers displayed an understanding of design processes for manufacturing and also vast knowledge of graphical communication. They had technical know-how or procedural knowledge and there were attempts to impart such knowledge to students using traditionalist styles. They taught the content accurately and the drawings on the chalkboard attested to this. However, the lessons often focussed on drilling of skills with no reference or linkage to teaching and learning with societal, environmental and cultural-historic values of the technological practices involved. Consequently the students also experienced the same limited disposition about technological practices as they were not challenged to think beyond the skills emphasised by the teachers. Designing of teaching and learning experiences that involve social-cultural and cultural historical activities may help enhance students' understanding and practices of technology. It is therefore essential for effective teaching and learning of technology, that the teachers have a broad understanding of technology and this should be targeted first for professional development of such technology teachers.

The teachers' traditionalist view of teaching impacted on their teaching, leading to passive learners and limited technological practices. The teaching practices appeared to be influenced by such factors as the curriculum policy guidelines, examination orientation, and limited administrative support. Besides resource constraints and broader organisational and social situations, the teacher contextual factors, such as teaching experiences and college training, may also have shaped their practices and hence their values and belief systems about technology. A professional development programme that broadens the teachers understanding of learning in technology to incorporate cognitively based instructional models might help to create the stimulating dissonance necessary for teachers to challenge their own previously held realist beliefs and practices. The professional development model for this programme is discussed in the next chapter.

CHAPTER FIVE

THE PROFESSIONAL DEVELOPMENT

5.1 Introduction

This section will present the professional development model and the workshops that were implemented to address the nature of technology, learning in technology, social views and curriculum issues. Teachers' reflections of the workshops and model lessons design by teachers in the second workshop will also be described. There will also be a summary of findings related to teacher learning arising from the professional development.

5.2 The Professional Development Model

The study investigated teachers' perceptions towards technology and technology education. The aim of the study was to help create a more comprehensive view and understandings of technology education while recognising teachers' background knowledge, technological content and pedagogy. In order to achieve this goal, a professional development workshop was undertaken with a focus on enhancing teachers' knowledge about the nature of technology, technological concepts and processes, and pedagogical knowledge as these were considered central to effective teaching of technology. The goal of the workshop was based on the understanding that broadening and deepening ideas about technology and technology education will help teachers to conceptualise teaching and learning in a meaningful manner (for example, Jones, 2006; Stein, et al., 2007) and may also effectively allow them to contribute towards technology curriculum design and development. As teachers' subject subcultures have been shown to significantly shape their stance on technology education, professional development for teachers had to take existing views, beliefs and practices into consideration so to help teachers position themselves towards reforming their views about technology education and to review their teaching practices.

The professional development workshop therefore, engaged the teachers to develop broader notions of technology and technology education using the model shown in Figure 2. The model involved teachers in four phases with each phase providing opportunities for reflection and teacher learning in subsequent phases.

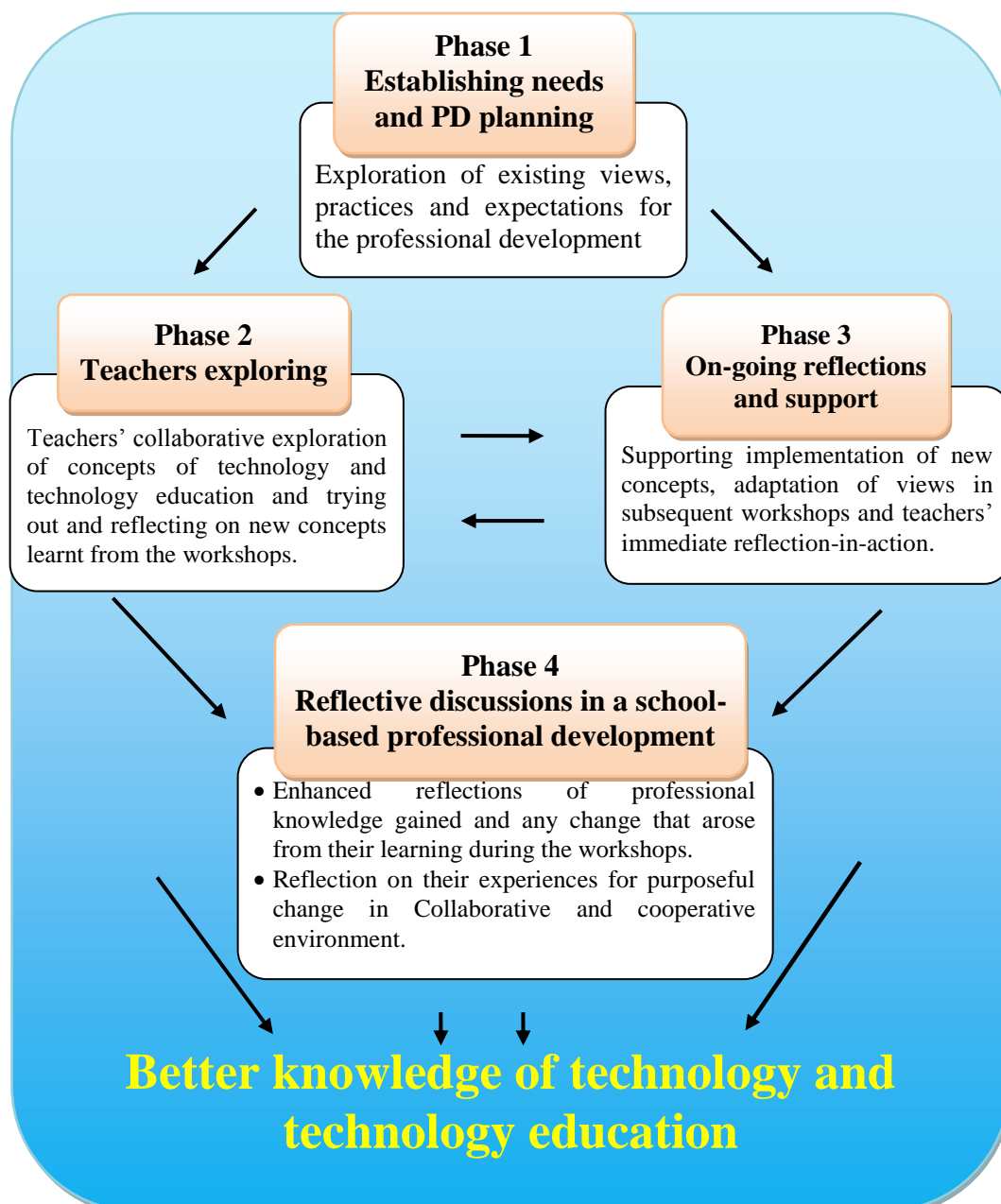


Figure 2: Professional development model for enhancing teachers' perceptions towards technology and technology education

5.2.1 Establishing needs and PD planning

The aim in the first phase was to generate an understanding of the teachers' existing views and practices through a research informed exploration process that involved a series of semi-structured one-on-one interviews, group interactions and also classroom observations. As the teachers taking part in the study were qualified technical teachers with wide technical teaching experiences ranging from 1 year to 10 years, establishing the teachers' existing views and practices was important in order to build on prior knowledge and practices when integrating new learning into existing theories and practices. The process was also enriched by the teachers' experiences as professionals with rich theories about teaching and learning, and what comprises desired curriculum content and outcomes. From here the model attempted to unlock teachers' beliefs and approaches to teaching in consideration of the nature of technology and technology education.

5.2.2 Teachers exploration of the nature of technology and technology education

The second phase of the model involved the teachers in exploring the nature of technology and technology education, learning in technology and curriculum issues through a series of professional development workshops. The workshops were staggered within a period of three weeks, with two sessions per week. The staggered arrangement allowed teachers time to reflect on previous sessions and to read and prepare material for forthcoming sessions. As there was no technology curriculum statement and related documentation, the teachers were involved in reading selected scholarly papers, making presentations of their views generated from the readings, and engaging them in a discussion about learning, curriculum issues and the concepts of technology and technology education.

The teachers were organised to undertake the tasks in their school groups in order to provide each other support, encouragement and begin to build a community of learners. It was also seen from other research (Compton & Jones, 1998) that sustainable change arises in an intervention where teachers play an acknowledged, legitimated and rewarding role in the change process. The teachers in this research therefore, explored the new concepts through readings provided in the workshop and sharing their experiences in their school groups. Through the use of social

cultural conceptual frameworks the teachers collaboratively supported one another during preparations for the presentations and they also provided each other support towards developing concepts new to them. Incorporating social cultural frameworks helped teachers encourage each other and begin to build a community of learners for fostering their own further professional growth leading to improvement of their classroom practices.

5.2.3 On-going reflections and support

The third phase of the model included teachers' reflections and support through on-going classroom observations and teacher meetings. On-going reflections and support helped to enhance teacher learning and sustain change towards adopting new teaching practices. Research (Dow, 2006b) had also shown that effective teaching practices may result from a fundamental change in pedagogy but that change may also be influenced by factors bordering on the teachers' beliefs and theories about teaching and learning and their willingness to embrace the change. The interactions between the researcher and teachers took place in between workshops to provide opportunities for further discussions and consolidation of learning of new concepts covered in previous sessions. This phase also included teacher support towards developing materials for the next presentations. The support only involved them rehearsing and explaining their presentation plans and allowed them to choose their own content.

5.2.4 Reflective discussions in a school-based professional development

The fourth phase of the model included reflective discussions in school-based professional development programmes. School-based programmes were organised to enhance the teachers' reflections of professional knowledge gained and to support any change that arose from their learning during the workshops. Literature has shown many ways of reflecting on one's professional knowledge; these are mostly influenced by adult learning and social learning theories (for example, Banks, et al., 2004; Williams, 2008). This phase adopted approaches that involved collaborative and cooperative environments as research (for example, Shulman & Shulman, 2004; Williams, 2008) appears to emphasize the centrality of reflection and collaboration for teacher learning and development towards adopting new teaching practices. A stimulating and supportive environment was also considered

as beneficial for successful professional development. Such a set up allowed for collaborative relationships to be established between teachers and researchers while still being part of and sharing with teachers in the same school setting but with action directly contributing to teachers' own classroom practices. In order to ensure that professional development outcomes filtered into classroom situations, interactions in this phase were reinforced through researcher teacher meetings before and after classroom observations and further interactions in classroom situations. In recognition that technology is a social phenomenon and that there are social influences on change (Jones, 2003; Pavlova, 2005; Prislín & Wood, 2005), the model adopted approaches to enhance teachers' capacities to reflect on their experiences to enable purposeful change.

The school based programme was therefore planned as a way of developing a foundation that would help create an environment for sharing new beliefs and practices. The school based professional development covered the nature of technology and learning in technology by also discussing itemised PATT results. The teachers shared views on PATT and the interaction was followed with classroom observations to support them in the implementation of new gained concepts.

The section below describes the workshops, which targeted influencing change in the teachers' pedagogical beliefs and practices by teachers exploring their own understanding of the nature of technology and technology education, learning in technology and curriculum issues.

5.3 Workshop organisation

The professional development was organised into three workshops spread over three weeks and interspaced with teaching practices which enabled teachers to try out and reflect on new concepts during their classroom practices. Teachers were however, under no obligation to implement new ideas gained from the professional development as this would depend on the context and their ability to adapt and take on-board new teaching practices. There was also no technology education curriculum statement; consequently teachers were still implementing the current technical education curriculum within existing traditions, frameworks, values and beliefs.

The teachers were organised in their school groups and each group made presentations based on readings that centred on the following: the nature of technology; learning in technology; social views of learning and methods for teaching technology. The themes of the presentations were based on Masters papers in the New Zealand National Facilitator Training Programme (Compton & Jones, 1998) and contextualised with the teachers' existing beliefs and expectations of the professional development workshop. After each session, the teachers reflected on their understanding of technology and related implications for implementing technology education in Malawi. The workshops will be described below.

5.4 Teachers reflections at the workshops

This section presents a description of the workshops in which teachers made presentations in their school groups. Tables 3-6 show the workshop activities by schools, concepts covered and the teachers' reflections. A brief overview of each session is also presented followed by a summary of key findings that emerged from the discussion. The workshops covered the nature of technology, learning in technology, Social views and issues related to teaching technology.

5.4.1 The nature of technology

This section reports on the first week's discussions that focussed on the meaning of technology. The teachers made presentations based on their understanding of readings about technology (see programme in Appendix 7). The presentations included a discussion of components that constitute technology, the relationship between science and technology, forms of knowledge and knowledge transfer from one discipline for use in another. After presentations the teachers reflected on their views about the meaning of technology. Table 3 below shows the papers discussed by each school and also the teachers' reflections of the concepts covered in their presentations.

Table 3: Teachers' reflections about the meaning of technology and its relationship with science

School	Papers/issues covered	Teachers' reflections on concepts
Kabula	Paper 1- Understanding technology – what it is not.	<ul style="list-style-type: none"> • Technology embraces all human activities. • Technical education offers limited knowledge of technology. • Students should be exposed to all components of technology.
Shire	Paper 2- Technological knowledge forms	<ul style="list-style-type: none"> • Links across subject boundaries towards utilisation of all knowledge forms - theoretical and practical knowledge. • The development of Nsanje inland port viewed as a technology issue.
Mudi	Paper 3-The relationship between science and technology.	<ul style="list-style-type: none"> • Science as building knowledge while technology was viewed as making things. • Complementary subjects. • Knowledge transfer from one context to another.

The discussion showed that teachers struggled to conceptualise both technology and technology education. In one presentation they viewed technology as embracing all human activities while in another it was viewed as making things as emphasised in the current curriculum.

While science involves building knowledge, it seems technology is about getting things made and that's exactly what we are teaching. (Buli)

Not really. In technology you do more than making chairs in the wood workshop. Making is just a component of technology as in Layton (1993). (Zagwa)

So, are we not teaching technology? (Mdzulo)

I doubt it... unless we include the other components such as values, culture, organisation, scientific explanations etc... it's just craft techniques and knowledge of tools and materials. (Zagwa)

The teachers were able to see broader notions of technology to achieve students' technological literacy by offering a curriculum that incorporates all components of technology and promotes links and transfer of knowledge and skills across

domains. The discussion that followed, therefore, may have helped to engage them in better understanding technological activities and collaborative discourse.

The teachers suggested that teaching in technical education should incorporate learning that enhances thinking and reasoning to develop capabilities to apply the knowledge in other situations. However, the teachers struggled to illustrate the concept of knowledge transfer across domains. This was shown by the teachers' views about the role of scientific knowledge, craft knowledge and experience in learning technology leading to their suggestion for teaching science and technology as a single subject. The teachers, therefore, appeared to associate technology with applied science. They were, however, able to distinguish scientific knowledge and technological knowledge by looking at historical perspectives of technological activities.

Science and technology are complementary and should be taught together as a single subject. Knowledge of science is needed in technology (Chiipira)

Yes, but a cathedral in Scotland and the pyramids in Egypt were built without any scientific background. Science supports life but historically people lived without knowledge of science. (Didi)

I think science is very important in learning technology otherwise we remain as indigenous and primitive as in the Stone Age. Doing does not need any science but learning enhances prospects of designing modern and advanced artefacts. (Zagwa)

In their arguments the teachers noted examples of activities in medieval times that showed other forms of knowledge that may have been key towards the construction and experimentation of structural design. They noted that trial and error may have been used as a major technique for learning and doing technological activities. The teachers therefore, viewed technology as a human activity to address needs although they still associated such activities with making or using things and products.

The development of new ideas using already acquired knowledge. (Zagwa)

Just to extend it... probably for human use. (Buli)

Yeah, I think so, because everything is taking place for human use.
(Zagwa)

I suppose the acquired knowledge could be through a process of learning. A person can learn and acquire some knowledge and also through practical experience or hands on experience with the actual technology which is being implemented, or the actual product. (Didi)

At this stage of the programme the teachers' views were still tentative. Further engagement of the teachers on issues of teaching and learning technology helped shape up a coherent understanding of the nature of technology and technology education. The second session covered the teachers' presentations and reflections on learning in technology.

5.4.2 Learning in technology

The second professional development workshop that took place in the second week involved the teachers in a discussion of concepts about learning in technology (see workshop programme in Appendix 7). The concepts were those related to technological knowledge and technological practice. The teachers had paid particular attention to design, problem solving, project based learning as technological processes and as pedagogical approaches for teaching and learning technology. These approaches were however premised on teachers' creative and innovative potential to plan programmes that promote enculturation, active participation and situating learning in authentic contexts meaningful to student needs and experiences. They also noted the vitality of students' experiences with new technological concepts and processes and also availability of information and capabilities necessary for problem solving. However, resource availability was viewed as posing a major challenge and hence the teachers' creativity seemed critical in developing programmes that broaden students' information sources and to look within before focussing on what is outside. The issues discussed and the teachers' reflections after the presentation of their readings are shown in Table 4.

Table 4: Teachers' reflections about learning in technology

School	Papers/concepts covered	Teachers' reflections on concepts
Kabula	Paper 1 - thinking, reasoning and problem solving.	<ul style="list-style-type: none"> • The technical education curriculum should emphasise problem solving to empower students' reasoning and thinking. • Lack of experience with new information and previously acquired knowledge related to technology may affect student engagement in problem solving
Mudi	Paper 2 - knowledge types, active learning, and learning related to enculturation and participation, situated learning and authentic activities or problems.	<ul style="list-style-type: none"> • Learning programmes should incorporate collaboration models among students and encourage interaction with expertise at various levels to enhance enculturation. • Culturally meaningful activities motivate students to learn and hence the need to situate learning in authentic contexts through which students may reflect their own lived experiences. • Noted strategies for problem solving and that they have in the past practised and experienced 'vener accomplishment' (McCormick, 2004: 26) when teaching design and during their college training. • Design and problem solving were viewed as the same concept.
Shire	Paper 3 - Project based learning (PBL)	<ul style="list-style-type: none"> • PBL may help involve students in the learning processes by also reflecting on the students' real world. • They said: 'experience is the best teacher' • Use of authentic contexts helps in learning as students get motivated by their experience of real situations. • Learning through collaborative work with expertise from within and outside the schools needed to be explored.

In the discussions, the teachers had shown some knowledge of technological concepts and processes and also pedagogical knowledge for teaching technology. They discussed design and problem solving and also pedagogy that promote student social development skills such as learning programmes which incorporate

collaboration models among students and encourage interaction with expertise at various levels to enhance enculturation. They also discussed the role of information and students' experiences with technological activities as vital for learning technology. However, the teachers also had difficulties distinguishing some technological concepts and processes but the debate provided them an opportunity to engage further and learn from each other's' views about the concepts. For instance in a debate about the distinction between concepts of design and problem solving, three of the teachers viewed design as the process of making new things while problem solving was reduced to viewing it as repairing faults of existing products.

I think design is a process leading to development of new things while problem solving has to do with already made things and probably you try to rectify some faults. (Buli)

I would say problem solving is general and designing is part of problem solving. Of course when we are solving problems we are not necessarily always designing. (Zagwa)

There is a very thin line because when designing you are solving a problem. Any design serves a purpose which requires answering a certain question or a problem. (Didi)

It seems these concepts may be used interchangeably. When designing, you follow a process of problem solving. But if we break something, we just solve a problem. We may not even engage ourselves in a design process per se. (Zagwa)

The teachers viewed problem solving as involving both general and structured processes. Consequently, they viewed design as constituting a part of that systematic process of problem solving. However, their understanding of design was restricted to the traditional design approaches of design-make-appraise leading to product development. Their views may have implications on their pedagogical practices as they viewed design as a linear process and generalisable, thereby limiting students' creativity and open mindedness although this is more a reflection on their practice knowledge. However, the teachers were able to discuss

concepts related to knowledge and learning in technology and how design and problem solving could be implemented.

The teachers also noted student participation and active learning through collaboration with their peers and experts as major concepts of learning which they were unable to exploit in their teaching career. Teacher strategies and knowledge about how to implement such pedagogies were viewed as important towards enhancing student learning. The teachers were then asked how student participation could be employed to maximise student learning. While others viewed participation as using the traditional talk-and-listen techniques in a classroom situation, Didi described another approach where, in his own view, students would be involved in authentic activities while learning theories, and also developing the student's capabilities in a practical activity related to such theoretical concepts.

An authentic project can involve students in learning how to present drawings and applying the skills in a production project in metalwork. For example, students can work together in the design of a basin, using knowledge of sheet metal development and drawing skills to design the basin on paper. The students would share roles in drawing a template to scale, cutting the sheet metal, folding to the design and finishing the seams. (Didi)

While there seemed to be attempts to plan authentic learning contexts, Didi's example of student participation did not seem to include situations meaningful to the students. The example showed that the teacher would pre-design the project and students' activities appeared restricted to the teacher's plan. The collaborative design and production processes included in the example also appeared to involve less thinking and reasoning but merely involved sharing manual drawing skills, sheet metal cutting roles and product finishing. The example also showed attempts for knowledge transfer from a drawing context to actual metalwork production but the structure of both subject areas contained development as a topic, which makes it difficult to conclude whether any use of drawing knowledge would be a consequence of transfer or a result of new instruction in the same unit. The example also showed attempts to include project based learning but there were no

indications of any exploration of the problem being addressed by the project. It was therefore seen that the example emphasised the teachers' belief in teacher made design problems as they also just maintained their pedagogical beliefs related to the craft and skills based learning.

An activity was planned to further engage the teachers in demonstrating their understanding of the concepts discussed in this session. This activity involved the teachers designing a lesson for a technology unit of their own choice, with the teachers working in their school groups. The teachers presented their models of technology lessons developed in their school groups and the lessons are described below.

During the second session, the teachers also presented model lesson plans for teaching a technological unit based on their current understanding of technology and technology education. As the professional development had thus far covered the nature of technology and also learning in technology, the lesson sketches provided a brief overview of the teachers' conceptualisation of learning in technology. The teachers planned the lessons in their school groups and decided their own lesson planning frameworks - largely based on their current practices. Their lessons are described in Table 5 below.

Table 5: Teachers model lessons presented during the second week

School/topic	Aim	Student activities	Teacher support	Pedagogy/ concepts
<i>Kabula: Design and production of a kettle</i>	<ul style="list-style-type: none"> - To design and produce a kettle using sheet metal. - To learn concepts of sheet metal development, production and drawing. 	<ul style="list-style-type: none"> - Design kettle - Make a template of kettle - Produce kettle - Research and visits to tinsmiths to learn joining methods of sheet metal. 	<ul style="list-style-type: none"> - drawing of kettle as shown in figure... - organise metal plates A and B 	<ul style="list-style-type: none"> -Project based learning -Design of community practice
<i>Mudi: Assembly drawing.</i>	To teach students how to draw to scale, present accurate measurements and to assemble and explode views of components.	<ul style="list-style-type: none"> - Industrial visit to learn assembly systems in manufacturing companies where they would also learn reading and interpretation of manufacturing drawings. - Group work before individual assignments. 	<ul style="list-style-type: none"> -Question sourced from a textbook and involving the assembly of an engineering object given its detailed drawings. - link with industry 	<ul style="list-style-type: none"> - Repository based skills -Craft and collaborative learning of practice
<i>Shire: Design of a cement mixing device.</i>	To design and produce a container for mixing sand and cement during the construction of brick structures in rural areas. The problem was that local builders in the rural areas were assumed to lack equipment for mixing sand and cement during construction. The builders could not afford motorised mixers and needed something cheap and simple to use as most of them were poor villagers with little or no education to understand any tool that required mathematical formulae and technical knowledge.	<ul style="list-style-type: none"> - Visit local builders to learn how to mix sand and cement and the appropriate mixing ratios. - Visit local tinsmiths to learn sheet metal development. - grouped to work collaboratively. - design the mixer. - develop a template and - Produce a prototype for testing at any building site within the schools' neighbouring villages. 	<ul style="list-style-type: none"> - Link with local builders and tinsmiths - Supervise groups 	<ul style="list-style-type: none"> -Problem solving design of practice -community collaborative learning in design process

The teachers attempted to include concepts of learning such as situated cognition, collaborative learning, authentic contexts and also learning in communities of practice as shown in Table 5. However, their shift from traditional practices to adopt these concepts appeared temporal as they still identified some of the practices with their behaviourist perspectives. Teachers from both Kabula and Shire included project based learning through which students were going to experience design processes and problem solving. While teachers from both schools seemed to hold knowledge about design, their pedagogical approaches were different. Kabula teacher's design process involved them providing most of the information that would be needed by the students to complete the designs. The information included a teacher crafted design brief and design sketches of the kettle (see Figure 3).

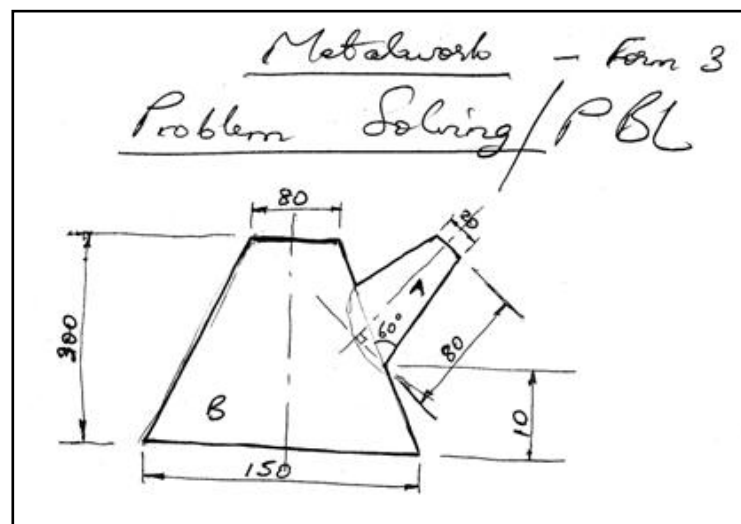


Figure 3: Drawing of a kettle by the teacher

They also chose the type of metal which the students were going to use for this particular design activity. Kabula secondary school was also unable to provide a clear situation needing the design. On the other hand, Shire secondary school had developed a situation for design and students were expected to follow conventional design processes. Their students would also be required to test their product from which they would provide an evaluation of the functionality of their artefact. The teachers also showed some knowledge of how to situate learning in contexts where the skills would be useful as shown by their planned visits and

student attachment to communities of practice (tinsmith, building and construction sites) where the knowledge would be useful.

However, student engagement in such communities required adequate support. No school had provided any description of the industrial contexts where student learning would take place other than brief expectations of what the students were going to learn. A clear outline of student activities would help guide and monitor student-expert interaction and student learning and progression while in the communities of practice. Further engagement of the teachers in theories that underpin the concepts of learning may help them meaningfully conceptualise teaching and learning in technology. The third session involved the teachers discussing concepts related to social views of learning; these will be discussed in the next section.

5.4.3 Social views and issues related to teaching technology

This section reports on the discussion during the last workshop that took place in the third week of the professional development programme. Teachers made presentations of their readings and interpretations of the papers that focussed on social views of learning and issues related to teaching technology (see workshop programme in Appendix 7). They discussed concepts related to situated cognition, learning in communities of practice, cognitive apprenticeship, technology education traditions, and issues related to technology education curriculum and design as a methodology for teaching and learning technology. Table 6 shows the concepts that were discussed and teachers' reflections after presentations by teachers from each of the three schools.

Table 6: Social views and issues of teaching technology

School	Papers/issues covered	Teachers' reflections on concepts
Kabula	Paper 1 - Situated cognition and collaborative learning	<ul style="list-style-type: none"> - We need to shift from deductive approaches common in technical education classroom practices. - Assessment challenges as examinations are central to school culture.
	Paper 2 - Technology education curriculum issues	<ul style="list-style-type: none"> - Students not as motivated to take responsibility of their own learning and to work independently. - Interactive and open ended approaches will be difficult to implement in Malawi as students and even teachers are used to the teacher taking a leading role and transmitting the knowledge and skills. - Political, educational and economic views will take centre stage towards influencing the framework for technology education.
Mudi	Paper 3 - Learning in communities of practice	<ul style="list-style-type: none"> - Learning with experts or practitioners-availability problems. - Malawi's small industrial base concentrated in Blantyre will be a problem for most rural schools such as Shire secondary school.
	Paper 4 - The evolution of current practices	<ul style="list-style-type: none"> - Understanding evolution is essential for developing curricula that gets rid of weaknesses and builds on strengths of previous practices.
Shire	Paper 5 - Situated cognition and cognitive apprenticeship	<ul style="list-style-type: none"> - Learning is effective if situated in authentic contexts meaningful and relevant to students' experiences and needs. Most students' experiences may not be related to technology but most need to be associated with its use in daily life.
	Paper 6 - Design methodology	<ul style="list-style-type: none"> - It takes a critical eye to see a problem. Otherwise everything is culturally and traditionally okay and normal. - Avoid design rituals. - Look at issues from a broader perspective.

The discussion and reflections of the social issues related to teaching and learning technology (see Table 5) showed the teachers developing an understanding of curriculum models and practices suitable for enhancing student technological

literacy for social development. The teachers also appeared to identify challenges that may impact on the implementation of such models. They showed the centrality of both student and teacher beliefs, school culture, lived experiences, industrial support and linkages and the role of political, economic and educational views towards adopting new curriculum models and practices. For instance, the teachers suggested a shift from traditional deductive approaches to adopt interactive and open ended approaches that challenge students' thinking and reasoning through problem solving and design.

Although in our culture sometimes we don't see a problem where there is a problem... our goals should be for students to become independent problem solvers, to be able to see problems. They should become creative, reflective, critical and expressive... I don't think we give them capabilities to be creative, reflective or critical. (Buli)

While the teachers appeared to favour interactive approaches, they also noted problems that may impede implementation of such pedagogies in their classrooms. These included cultural beliefs, assessment practices and a small industrial base leading to lack of experts or practitioners, technologists or models for student learning, particularly in rural settings. However their views about practitioners or models appeared to be based on a narrow understanding of technological pedagogy and practices as they only focussed on learning involving advanced and high-tech situations in industry.

The teachers also discussed the traditions or evolution of technology education and premises for establishing technology as a learning area. The teachers appeared in favour of traditions that foster learning in communities of practice and use of cognitive apprenticeship. They noted that most students in schools were not motivated to take responsibility for their own learning and the students also believed in the teachers taking a leading role. As such, curriculum models that would help enhance student capabilities to take control of their own learning, were viewed as important towards improving student learning outcomes, which would also contribute to their further learning after school. Hence, a curriculum that incorporates the tradition with the principles of industry, productive work and education was preferred as they viewed it as reflecting government policy

direction for a shift of Malawi's economic agenda from a consuming and importing nation towards a producing and exporting nation. This view however, appeared to be influenced by their current practices and beliefs in motor skills development. The teachers' choice of the industrialist's technology tradition was hence largely influenced by political and economic views that focus on life after school. The tradition was viewed as an option that could provide students with industrial experiences to consolidate their classroom practices but that also seemed to be a ploy to provide a workforce for industry and also to mitigate youth unemployment. However, the need for social cohesion and development also seemed appealing to the teachers. Hence they viewed a curriculum that fosters a strong link between classroom practice and cognitive practice for students to become strong 'out of school' learners as essential for achieving such assumptions. The teachers appeared to still strongly hold the view that technical education offered children capabilities and skills to meet societal challenges.

If one drops out at Form 4, is that student able to participate and function effectively in society, personal or political life? In exceptional cases some have developed workshops... I think it's possible in technical education but I don't know for the other subjects... even if somebody drops at Standard 5, learners should be able to support society. (Buli)

The teachers also mentioned the problem of students' lack of experience in technology related activities which they attributed to Malawi's lagging technology. However, this view also appeared to associate technology education with processes that involve high-tech activities. Students were said to come from rural areas where advanced technological activities were almost non-existent and their only experience may be related to indigenous technologies. The teachers therefore needed further knowledge of technological and pedagogical practices to be able to conceptualise learning that incorporates broader notions of technology and technology education to be able to realise that communities of practice are boundless and exist everywhere and not necessarily restricted to industry and manufacturing.

The teachers also debated the differences between problem solving and design. They still struggled to conceptualise problem solving and design after noting

arguments by Williams (2000) where it was said that problem solving begins with a problem while design may not necessarily begin with a problem. Their views appeared to show that design addresses a question or a problem at all costs, even when the design process is reversed or the problem is ill-defined. The teachers however, argued for a better understanding of the epistemological assumptions of the design process as it was viewed as a major aspect in problem solving and technology education in general.

Overall, the teachers appeared to show an understanding of social views of learning in technology and positioned their practices and contexts in perspective of such theories. As the teachers had shown some knowledge of pedagogical approaches for teaching technology, further engagement of the teachers in their classroom situation may help understand their ability to shift their beliefs and put the theories into practice.

5.5 Summary of key findings from the professional development programme

This section summarises key findings that arose from the professional development programme. The findings were as follows:

- Effective professional development model that incorporated teachers existing beliefs and practices.
- Enhanced teachers' views of the nature of technology and technology education attributed to support and reflection.
- Enhanced teachers' understanding of teaching, learning and curriculum issues related to technology.

The professional development programme took into account teachers' existing views, beliefs and practices to help them position themselves towards broad notions of technology and technology education. Social cultural frameworks of learning underpinned the professional development processes which involved group preparation and presentation of their interpretation of readings and completing group tasks on instructional design. Teachers supported each other in

learning new ideas. The workshops were interspaced with classroom observations, allowing teachers to try out new concepts in the classrooms.

In order to expand the teachers' understanding of the notions of technology and technology education, the teachers were engaged in reading and leading discussions of papers that covered the nature of technology, learning in technology, social views of learning and curriculum issues in technology education. As the professional development was not curriculum based, through the readings, teachers discovered, on their own, new concepts of technology and technology education. It was revealed that teachers developed some concepts of both technology and technology education leading to their understanding of broader notions of technology. For instance the teachers noted that for student technological literacy a curriculum offering should incorporate programmes that promote links and transfer of knowledge and capabilities across domains. They also noted the need for programmes that enhance thinking and reasoning. The teachers also distinguished scientific knowledge from technological knowledge by cross examining historical perspectives of some of technological activities they had experienced.

In their reflections of learning in technology (see section 5.4.2) the teachers had shown knowledge of technological concepts and processes and also pedagogical knowledge for teaching and learning technology. They argued over their understanding of design and problem solving leading to their viewing design as a subset of a systemic problem solving process. They had also shown knowledge of collaborative learning models to promote student active learning.

Teachers also interacted over readings related to curriculum and social views of learning in technology and their reflections showed an understanding of the merits of interactive approaches, curriculum models and practices that enhance student technological literacy for social development. They linked such models with concepts of communities of practice, cognitive apprenticeship, authentic contexts, information and communication, and students' experiences with technological activities for meaningful learning.

The teachers were also challenged with an instructional design practice where they planned a lesson of a technology unit of their choice in which they decided

their own pedagogical techniques based on the content covered during the workshop interventions. Teachers from a rural school were able to include aspects of learning that would help develop students' technological knowledge and technological practice while teachers from the other schools maintained their traditional pedagogical practices related to teaching and learning for motor skills development. The teachers from the rural school had shown greater innovation in implementing new things and their lessons included aspects of technological pedagogy that focussed on collaborative learning and use of authentic contexts identified in their own rural setting. Therefore it may be concluded that any school, rural or urban can implement learning programmes for technology as long as the teachers possess a broad understanding of technology and technology education.

Although the teachers' conceptualisation of learning in technology was still fragile, it has been observed that any attempts to shift the teachers' beliefs and practices will not be an easy task. More interventions would be required if teachers were to adopt and implement broader notions of technology and technology education. Activities in the professional development may not have adequately measured the teachers' assimilation and understanding of new concepts, but they show group members' innovations influence effectiveness of collaborative learning frameworks. Following up the teachers in the schools for classroom observations helped provide further understanding of their teaching practices and whether that would reflect any shift from their existing practices and views about their knowledge of technology and technology education. Classroom observations and teachers' reflections will be reported in the next chapter.

CHAPTER SIX

TEACHER REFLECTIONS AND PRACTICES

6.1 Introduction

The final post-intervention data collection was undertaken towards the end of the school year to allow the teachers reflect on the knowledge gained during the professional development. This approach was taken because, while the teachers may also have been reflecting-in-action on what was learnt during the professional development, a three months gap may have allowed their reflections to mature into a meaningful change. Reflections over time would also provide some indication about the sustainability of this programme. As a way of providing that support, the research involved the teachers in researcher-teacher discussions in groups or one-on-one, classroom observations and interviews and discussion of PATT results. The teachers' reflections are discussed below.

Reflective interviews were conducted in each of the sample schools with four teachers: Zagwa, Didi, Buli and Chiipira. The fifth teacher from Kabula secondary school was not available as he was away for invigilation of national examinations. As in the guide, the interviews focussed on the meaning of technology and technology education, implementation of technology at school level and influences of the professional development on the teachers' views of technology and technology education. Below is a description of the teaching practices, the teachers' views as discussed in the face-to-face reflective interviews and also their reflections of PATT results.

6.2 Teaching Practices after the Professional Development

The professional development was aimed at enhancing the teachers' perceptions towards technology and technology education leading to improved technological pedagogical knowledge and practices. Table 7, Table 8 and Table 9 below show tabulations of records of each of the teaching practice observations. It was shown from the observations reported in the tables that the teachers were more innovative and they attempted to include concepts of learning in technology. Zagwa and Didi's lessons (see Table 7 and Table 9) demonstrated skills related to

construction of helices and sectioning of objects but they also included in their lessons real life examples as models or teaching aids for their lessons. Examples included a v-block, threaded shafts, recycled paper, and a wire coil rolled over a paper to show a left-hand movement or rise of a helix as in Figure 4. However, students struggled to conceptualise the concepts as the contexts were also not meaningful to their experiences. For instance, in Zagwa's class only one out of eight students was able to complete a drawing which is shown in Figure 4.

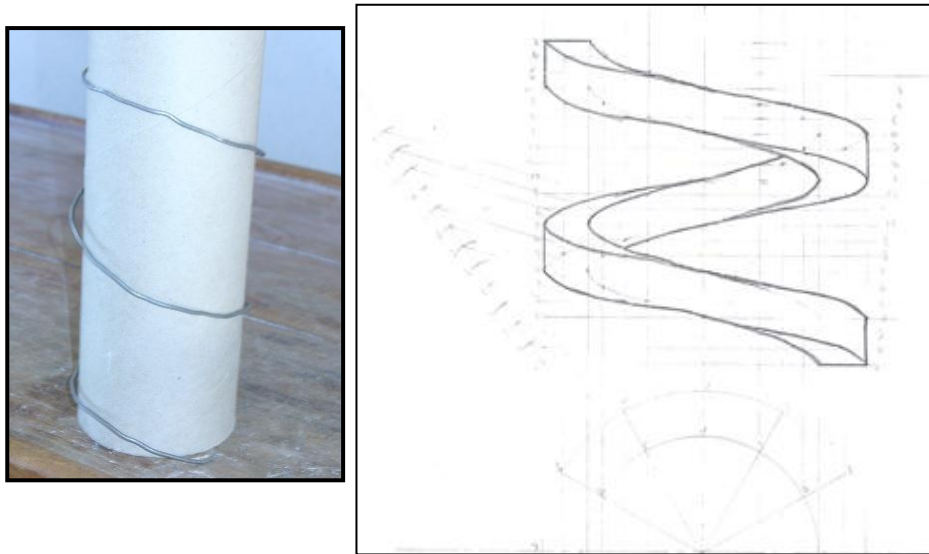


Figure 4: Model of a helix using a wire coiled on a paper roll and a student drawing shown on the right

The teacher explained the process of tracing the helix using the model but the other students were unable to conceptualise it. This was also compounded by the fact that the model had a round wire while the question and demonstration involved a square section wire. The student that completed it considered the square section wire as containing four helices and this aspect required the students to think.

Didi's lessons (see Table 9) also included students working in groups to share knowledge on construction procedures but the tasks were not challenging enough for students' thinking and reasoning although students were seen applying knowledge from mathematics when taking measurements of the objects. It was also seen that the process of measuring thread depth was unconventional as

mostly the design and production of threaded components follows set standard guidelines and procedures which students needed to practice.

Buli (see Table 8) planned different activities for students including group work to develop templates and a visit to a local tinsmith (see Figure 5) to learn basic sheet metal development processes. The group work involved developing mock-ups for a wheel barrow using ordinary A4 size paper. The students were given verbal instructions which included that they were to share roles, skills and knowledge about how to make the mock-up. All the groups except one began their tasks by cutting and folding the paper to form the shape of a wheelbarrow. One group decided to sketch a template with all sides joined and their last activity was just to fold the paper into the sketched shape.

The class also visited the school cafeteria to compare their mock-up wheelbarrows with a real one in use. The contexts seemed authentic and meaningful to students learning as he used familiar activities and products such as soap packages, pails mostly used in villages for collecting water from boreholes (see pail in Figure 5).



Figure 5: A tinsmith demonstrates how to make a pail

These appeared meaningful as most students were from rural areas with no basic amenities such as tap water in their homes. However, while the lesson included some collaborative learning, the activities did not involve much thinking and

reasoning to solve problems related to home activities. The homework given to students involved a question from a drawing book which only tested drawing skills. Overall the teachers had attempted to apply the knowledge gained from the professional development. Further engagement, support and encouragement to adopt new practices may be required to improve the innovation and planning instruction that enables teachers to enhance students' technological literacy.

Table 7: Zagwa's Classroom observation record after the professional development workshop

Name	Topic	Teacher activities	Student activities	Comments
Zagwa	Helices-left hand square springs	<ul style="list-style-type: none"> Discussed with students the application of helices e.g. screws, machine vice threads, helical stairs in buildings. Demonstrated construction process of a helix by drawing on the chalkboard. Wrote notes for each construction step on the board during demonstration. Wrote class exercise on board for students to draw two-and-a-half turns of a left hand helical spring. The question was picked from a drawing book. As students struggled to draw, he used a wire coiled around a paper roll to demonstrate left/right hand springs. 	<ul style="list-style-type: none"> Drawing following the example as demonstrated by the teacher on board. Few completed exercise but more failed to trace the helix. Homework was given and to be submitted the following day. 	<ul style="list-style-type: none"> Students had difficulties conceptualising the views.
	Sectioning	<ul style="list-style-type: none"> Demonstrated sectioning on the chalkboard using a model of a V-block. Question and answer about the conventions used in sectioning including components that should not be hatched. Explained the significance of hatching lines. Demonstrated by sectioning previous example which was on isometric drawing. Sectioned v-block by also asking students to do it on the board 	<ul style="list-style-type: none"> Explaining meaning of conventions used in sectioning processes and hatching styles. Students sketched a threaded shaft on board but core diameter was not shown differently from the outline. Sectioning parts of V-block on the chalkboard. Exercise involving sectioning of an isometric drawing but with a cutting line along the vertical axis. 	<ul style="list-style-type: none"> Sectioning lines or cutting planes seemed difficult for students to understand and the teacher planned to revise.

Table 8: Buli's Classroom observation record after the professional development workshop

Name	Topic	Teacher activities	Student activities	Comments
Buli	Parallel and radial line development of objects	<ul style="list-style-type: none"> • Revised previous lesson • Explained meaning of development by also disassembling a chalk box carton and a carton for soap. • Explained production process – development of patterns and templates and mentioned packaging industries that produces cartons using such techniques. • Asked students about their knowledge of how pails or watering cans are made in villages. • Prepared two tasks for students • Organised tools such as razor blades, masking tape. • Gave students an exercise on development. 	<ul style="list-style-type: none"> • Explaining production of chalk box though most of them fumbled. • Worked in groups of 3 to design wheelbarrow using pieces of cardboard paper. • Students attempted to obtain the correct shape of wheelbarrow by try-and-error. Only one group made a template and transferred drawing to paper for making a mock-up for a wheelbarrow. • Considered users and general community. • Designing a pail with one seam and none completed it. • Observed tinsmith processes using his local tools just outside staff houses. Tinsmith explained (see Figure 5) cutting and joining of sheet metal to form desired shapes for decorations • Exercise to be completed during own time after reading construction procedures from a drawing book. 	<ul style="list-style-type: none"> • As students could not make a mock-up of a pail, a visit to a tinsmith assisted them to conceptualise development. • Students were motivated learning from a tinsmith. • Students said it was a good lesson and will attempt to apply the skill in the villages.

Table 9: Didi's classroom observation record after the professional development workshop

Name	Topic	Teacher activities	Student activities	Comments
Didi	Helix. Targets: <ul style="list-style-type: none"> to enable students to construct helices to enhance students understanding of practical applications of helices Enhance construction abilities and improve speed. 	<ul style="list-style-type: none"> Prepared materials which included tissue rollers for students to trace a helix. Discussed paper recycling. Defined pitch, diameter and their applications in tracing a helix. Organised roundtable discussion on aspects related to manufacturing of rollers and environmental concerns. Demonstrated construction of a helix while students were drawing it. 	<ul style="list-style-type: none"> Sketching exact shape of roller Discussing group work Drawing as teacher demonstrates 	<ul style="list-style-type: none"> The teacher was satisfied with students work but planned to include more student activities in next lessons. Teacher observed lack of student interaction during group work.
	Helix – cont.: 2-start and 3-start threads.	<ul style="list-style-type: none"> Defined 2-start and 3-start threads Divided students into 2 groups of 4. Explained tasks for each group 2-start group was given a question to draw threads and 3-start group was given a threaded shaft to take measurements and draw the threads on paper. Checked student learning progress in each group. 	<ul style="list-style-type: none"> Discussing their assigned group exercise. 3-start group measured shaft circumference by using paper rolled over the bar and obtained its radius using a mathematical formula. 2-start group discussed procedures of constructing the helix. Each student worked on individual drawings from their respective group work. 	<ul style="list-style-type: none"> Students complained of lack of precision tools to measure shaft The teacher said that the targets were attained as students were enthusiastic (groups to swap exercise the next day)

Only one teacher introduced new pedagogical approaches to enhance student learning in technology, however this may just be because change at the personal construct level can be slow and gradual as it occurs on a level of belief and understanding (Stein, et al., 2007). The teachers attempted to adopt new pedagogies although their practices emphasised behaviourist beliefs about learning thereby focussing on lecturing and demonstrations for student skills development. The teachers were often focussing on practicing skills rather than involving students in design or problem solving approaches to develop students' intuitive technological capabilities.

During the final post-intervention data collection teachers reflected on the knowledge gained during the professional development. The findings for these reflections are discussed in the section below.

6.3 Teachers' reflections

6.3.1 The nature of technology and technology education

The teachers in this study associated technology with the technical aspects while culture, societal values and beliefs were less prominent in their discussions. The teachers' definitions of technology were as below:

...the use of acquired knowledge and skills for developing modern or better ideas and solutions to existing problems. (Zagwa).

...a process of analysing situations for improving one's activities using available resources. (Chiipira).

...all about the human mind and behaviour related to improving things with respect to culture and societal values. (Didi).

...information, knowledge or skills that could lead to production of artefacts for man's use. (Buli)

As technology was seen as developing products that meet human needs and wants, the teachers' understanding of technology in this study suggests that they held enhanced and positive views about technology. However, their views were

not broad enough to incorporate social-technical aspects of technology. Only one teacher had shown broad understanding of technology by recognising its relationship with culture and society.

On their understanding of the meaning of technology education, the teachers considered it as:

education designed to promote the teaching and learning of technology to enable students use existing knowledge for solving problems. (Zagwa).

a process of teaching and learning technology and teachers work collaboratively to support students to think and solve problems. (Chiipira).

education for giving students technical know-how for production of things and making things better. (Didi).

acquiring of information, knowledge or skills for production of artefacts for man's use. (Buli).

The teachers' views of technology and technology education as influenced by the professional development suggest an important shift. However, their views show them being influenced greatly by the traditional technical subjects and it may take a while for them to adopt approaches that support learning in technology. The teacher beliefs or theories may present as barriers to adopting new strategies and implementing new curricula. The emphasis on skills or technical know-how, have been the norm and to shift towards addressing the socio-technical processes will require further professional development with consistent follow-up, support and reflective programmes.

6.3.2 Implementation of technology at school level

The teachers' views towards implementation of a technology curriculum at their schools varied from one teacher to the other. Others suggested a review of the curriculum to incorporate technology as a learning area while others provided scenarios or situations that suited their schools for implementation of the subject. For instance, Zagwa, suggested the need to change the curriculum to focus on

giving students capabilities to work on their own and also to be able to use locally available resources. He said:

We need to change the curriculum to give students a chance to do things on their own other than feeding them with solutions. In metalwork we should minimise emphasis on use of machines as we also do not have enough machines to go round during practical lessons and examinations (Zagwa).

Zagwa mentioned that there are limitations to the extent Kabula secondary school can implement technology education as the curriculum is examination oriented. The other problem Zagwa mentioned was lack of management support to allow teachers to take students for industrial visits so students can learn in authentic contexts. Zagwa recently planned an industrial visit but management was not able to provide resources for hiring a covered vehicle as required by the Ministry of Education guidelines. Zagwa said:

We are in a city and most of the things and appropriate situations for learning technology are just outside the school gate. Normally we are discouraged from walking with students to such places unless students are ferried in a covered vehicle for students' own safety and security (Zagwa).

As a result, Zagwa used contexts within the school premises which did not provide as rich information the students would have gained from an industrial setting. Hence, Zagwa emphasized the need to change the curriculum to incorporate learning in technology if the country is to move towards technological literacy. As a curriculum provides policy guidelines, schools will be obliged to support activities for teaching and learning technology.

Zagwa also argued that technical subjects have been offered in schools since the 1970s but there has been no measurable impact. Although Zagwa was unable to provide evidence of his assertion, the schools' scholastic records show low student turn out at MSCE. For instance, between 1998 and 2007, the scholastic records for Kabula secondary school show only about 6.2% (71) of 1146 students enrolled in technical subjects. In the PATT data generated in this study, 10% (36) of 358 students completing the questionnaire indicated that they were learning

technical subjects (see Table 10). However, the number dwindles towards examination period as a large number of students drop out to concentrate on subjects that would help them attain better grades to qualify for university selection.

At Mudi secondary school, we discussed how the school can implement technology education and Didi preferred a project based learning (PBL) approach so that students could get involved in real projects. His support for PBL is contrary to his previous suggestion for work based learning (WBL). PBL was chosen as it would involve small and authentic tasks which can be completed within school programmes. His view of WBL was influenced by his school teacher but he considered the approach more difficult to implement because of the nature of the curriculum. The focus on examination would be a challenge for assessing students' progress under WBL.

In another meeting with Didi we discussed his understanding of project based learning (PBL), his preferred model for implementing technology education at Mudi secondary school. He explained his view by describing an example of a project that would be undertaken if technology was introduced as a learning area. His example was on water harvesting. He chose harvesting of rain water because of the persistent scarcity of water in the city of Blantyre and surrounding areas and slums. He said that he would brainstorm with students for possible solutions. Then the students would be taken for a visit at Blantyre Water Board for the students to learn about water conservation and treatment processes. After the visit, students would be asked to design water harvesting equipment to capture rain water that falls on all the buildings at Mudi secondary school. A huge reservoir and a lot of pipe work would be needed to store all the water from all the targeted buildings. He said the captured water would be enough for Mudi secondary school for the whole period when water becomes scarce. Didi said that the project would help students acquire some technological capabilities besides acquiring knowledge for water conservation which they can implement in their homes and societies. However, Didi said that implementation of PBL would be feasible only after establishing technology as a learning area. He argued that the current curriculum is rather restricting as it requires focussing much on examinations.

At Shire secondary school, Chiipira argued that technology education can be implemented by allowing students to examine situations within the school and the surrounding areas. Chiipira suggested that teaching should not be restricted to the use of machines as students may not be able to think beyond the machining processes. As machines are not commonly found in villages, students will be unable to participate in development activities. The knowledge therefore becomes obsolete and wasted. He argued that authentic contexts would be drawn from the tea estates and factories that surround Shire secondary school. He said that most of the students at this school come from smallholder tea growing families, tea factory employees and other surrounding institutions and villages. Chiipira mentioned that the tea environment provides situations students can explore to identify problems and develop their solutions. The situations may include tea picking, factory production processes, and blending and packaging of tea into retail bags. Buli had a different perspective as to how technology can be implemented at Shire secondary school. Buli believes that a practical approach would be more suitable for implementing technology where students would be allowed to produce tangible items in the workshops. He said: "I believe that 'seeing is believing', that's the way I feel we can teach technology at this school". He gave an example of production of waste management bins which students could do after learning sheet metal development skills in technical drawing. So authenticity and context were big on the teachers' agenda.

The teachers' understanding of the environment as sources of learning is important as it helps provide contexts to situate technology programmes and activities. The environment provides students with practical contexts where they can reflect, and develop and test ideas. The teachers appeared to have been empowered to negotiate for support towards implementation of technology as a learning area. However, the teachers still needed a much deeper understanding of the components of technology and implications for teaching and learning. Throughout the conversations, the teachers did not highlight the social organisation aspects of technology.

6.3.3 Influences of the professional development on the teachers' views of technology and technology education

The teachers talked about how the professional development programme influenced their understanding of technology and technology education. The influences mainly included change in teaching methods which included more student activity based learning and thinking processes. Some of their thoughts are described below.

Zagwa said that his views about technology and technology education were influenced by the PD and that he attempted to implement some of the ideas that were discussed during the PD.

... we have changed our teaching practices as a result of the PD. But in some cases, it is quite challenging. It's easier with some topics and yet with others it is somehow very challenging. (Zagwa)

He gave an example of the topic about the construction of auxiliary views. He indicated that he was unable to identify pupils' experiences and contexts that relate to auxiliary views, particularly lines in space. Zagwa, however, said that the PD changed his overall approaches to teaching and he said; "Our teaching previously focussed much on what we know and not what the pupils know". He also said that the curriculum should therefore help pupils think more and beyond the classroom content and this can be done by exposing the pupils to more exploratory work than just drilling them in machine work which they will not have any chance to use when they leave school.

Zagwa indicated that the professional development was very educative and he suggested that it should have been extended to all the technical teachers in Malawi. He mentioned that the professional development helped to enhance his views about technology and technology education and furthered his understanding of technical education. It also influenced his current approaches to teaching.

It was quite educative. One of the obvious areas where it actually helped me is about students' involvement. In the past, we were concentrating on giving out most of the stuff to the students, but now most of the things

come out from the students themselves. That's the major one which I can think of. (Zagwa)

However, Zagwa indicated that there are limitations to the extent they can implement the changes as the curriculum is examination oriented with emphasis on use of machines and tools. He also suggested attitude change towards the teaching of technology related programmes.

Didi and Buli commended that the professional development was helpful as they learnt new methods of teaching. Didi said that the workshop helped him understand how to involve students in doing social activities as a way of teaching technological concepts. He said this was missing in the current curriculum and wished for a review to be able to implement the new ideas. Buli said that the professional development was an 'eye opener' as they learnt how to get students involved and to appreciate why things are produced. He indicated that students had begun to show interest in learning unlike in the past when it was difficult to get students to do assignments.

... it was an eye-opener in a way that sometimes students do not appreciate why some information is being taught to them. But after the PD we were encouraged to make the students do the things and probably see the things in use. They seem to have started liking the subjects. Apart from that, the other aspect that we were ignoring that was introduced, like the cultural aspects that we were not putting much emphasis on. (Buli)

Buli also talked about the importance of incorporating and emphasising cultural and social aspects in learning technology.

... appreciating what is being used in the villages, and probably after that, then introduce improved items that are there that you want them to see and make; that connection will be important (Buli).

Chiipira said that his views about technology were influenced much by the professional development. He noted that there are changes in his teaching practices and he now includes practical and authentic situations in his lessons to help students understand and apply concepts even outside the classrooms.

Teachers are not given support to implement ideas in the field. He also said that teacher training colleges do not have follow up programmes to monitor new teachers' performance and experiences in the field and most schools have no induction programmes to orient new entrants into the system.

The PD was very important. In the teaching service, there are no refresher courses. We fail to implement what we learnt in college because of lack of support or induction. The PD was helpful as we discussed concepts we learnt in college and we also shared new ideas such as the project based learning... (Chiipira).

The professional development, therefore, helped to reflect on teaching practices by sharing experiences and challenges encountered by the other teachers. The sharing of experiences was helpful as it assisted them to check their own practices and in the process, change their perceptions. He also mentioned that he had learnt new theories, particularly, the concept of project based learning (PBL). He mentioned that the teaching and learning course in the teacher training college was too general and suggested a shift for the programme to incorporate relevant theories for the teaching and learning of technology or technical subjects. Chiipira also proposed that similar professional development should be organised frequently and that the professional development should, in future, involve a cross section of teachers in order to share a wide range of challenges facing the teaching and learning of technology related subjects and how to improve practice.

6.3.4 Approaches for teaching and learning technology

In separate meetings, Didi, Buli and Chiipira, shared their views about technology, preferred methods and theories of teaching technology. The teachers recognized that as technology was very broad, thorough planning was considered necessary if teaching practices were to embrace its broadest nature. On the methods of teaching technology, the teachers at Mudi secondary school suggested adopting a design and technology approach for skills development and for the enhancement of the students' cultural and organizational aspects of technology through collaborative design activities. The teachers at Shire secondary school indicated that, if given a chance to choose, they would go for a CDT approach, as

they believed that students need skills to be able to function on their own when they leave school. The discussion showed differences in their understanding and justification for technology education. It was also seen that identifying suitable contexts was a challenge, as most of their examples were more on skills development. However, both schools viewed their suggested approaches as incorporating project based learning to enhance students' capabilities to think and solve problems. More professional development programmes would help them to adopt better views suitable for planning and implementing a technology curriculum in whatever form.

The next section will present findings from investigations that involved the students of the participant teachers in completing a PATT questionnaire, in order to gain a fuller picture of their perceptions towards technology. Understanding learning from the students' perspective will help teachers' planning and design of meaningful programmes for learning technology.

6.4 Pupils Attitudes towards Technology (PATT)

6.4.1 Introduction

A PATT questionnaire was administered to Form Three (Year 11) students from the three selected secondary schools: Shire, Kabula and Mudi secondary schools. Besides generating Malawi's PATT model for understanding students' dispositions towards technology, the data was also used as a tool for discussions in school based teacher professional development meetings. The purpose of the discussion over the PATT results was to help enhance the teachers' knowledge base about students' perceptions towards technology as perceptions directly influence classroom practices and subsequently learning in technological concepts and processes (Jones, 1997). All the data were analysed using SPSS and only descriptive statistics were used during discussions with teachers in each of the schools.

The questionnaire was completed by 358 (191 males and 167 females) students from the three schools. At Shire secondary school, 142 students (75 males and 67 females) participated; 93 students (40 females and 53 males) were from Kabula secondary school and 123 students (63 males and 60 females) were from Mudi

secondary school. Table 10 shows students' subject choices and only nine percent (30 boys and one girl) were learning traditional technical subjects (technical drawing, metalwork and woodwork) while 21% (74) were doing home economics which was more subscribed to by girls than boys.

Table 10: Students' subject choices

Subject	Sex		
	Male (n=196)	Female (n=162)	Total (n=358)
<i>Technical Drawing*</i>	30	1	31
<i>Metalwork*</i>	6	0	6
<i>Woodwork*</i>	9	1	10
Home Economics	21	53	74
Science and Technology	18	8	26
Computer Studies	21	7	28
Science	193	159	352
Social Studies	140	74	214
Agriculture	163	121	284
Biology	194	161	355

**Traditional technical subjects*

The attributes also showed that only 20% have computers at home while 14% want to become engineers and 29% aspire to become medical doctors. Gender seemed to have played a greater influence in the students' subject choices and career aspirations which appeared to have skewed their attitudes and conceptualisation of technology. The second part of the questionnaire, B, was an attitude scale and the last part, C, was a concept scale.

6.4.2 PATT Modelling for Malawi

Modelling of the PATT instrument to suit Malawi's context involved the computation of reliability indices and factorability of the data that was administered in the sampled schools. After adjusting the items and ascertaining the factorability of the model, a factor analysis was attempted on both the attitude and concept scales of the PATT data and produced results comparable to other PATT studies conducted across the globe. The Malawi PATT model generated 55 items on the attitude scale and 28 items on the concept scale which can be used for a cross country study in future research. The modelling of the PATT

questionnaire helped to provide a reliable and valid tool for discussion during the school-based professional development programmes. The modelling of the attitude and concepts scales will be discussed below.

6.4.2.1 Attitude Scale

The students' attitudes towards technology were measured using a five point Likert scale. Participants were required to circle: SA, A, U, D, or SD if they strongly agree, agree, disagree or strongly disagree with a given statement. U was for 'undecided' if they did not fully agree nor disagree. The responses were scored 1 for strongly disagree to 5 for strongly agree and scores for the negative items were reversed. The attitude scale comprised 60 questions but after a reliability analysis was conducted on the data, five items that had the lowest item-total correlation were deleted. The deleted items are shown in Table 11 below:

Table 11: Deleted items of attitude scale

2	Technology is as difficult for girls as it is for boys.
10	You have to be very bright to study technology.
19	Boys are able to do practical things better than girls.
21	It is not difficult to work with a computer.
37	Boys are more capable of doing technological jobs than girls.

Deletion of these items was therefore considered appropriate to reduce their effect during further analysis of the data. The model therefore had 55 PATT items as opposed to over 60 items in other studies from which the current instrument was adapted (for example, Bame, et al., 1993). A Cronbach's alpha reliability coefficient was computed and as a general rule the alpha should be at least 0.7 (de Vaus, 1999; Lewis-Beck, et al., 2004; Pallant, 2007). The current study reported a 0.859 Cronbach's alpha which was comparable to the internal consistency reliability measures from other countries such as New Zealand - 0.84, the Netherlands - 0.84, Kenya - 0.58 and RSA- 0.66 (Burns, 1990; van Rensburg, et al., 1999).

Factor Analysis of attitude scale

A factor analysis is a data management technique for reducing variables to a size that best summarises information and whether the variables tap into the same construct (Coakes, Steed, & Ong, 2009). In order to determine the appropriateness of the factor analytic model, a correlation matrix was computed, and reported coefficients of 0.3 and above. Principal components analysis (PCA) was therefore applied. The factorability was also confirmed by a significant Bartlett's test of sphericity ($p < 0.05$) and a Kaiser-Meyer-Olkin of 0.807 which is above 0.6 (Kaiser, 1974; Pallant, 2007). Using the Kaiser criterion (Pallant, 2007), the PCA yielded 17 components with eigenvalues greater than 1. These components explain a total of 60.693% of the variance.

Scree Plot

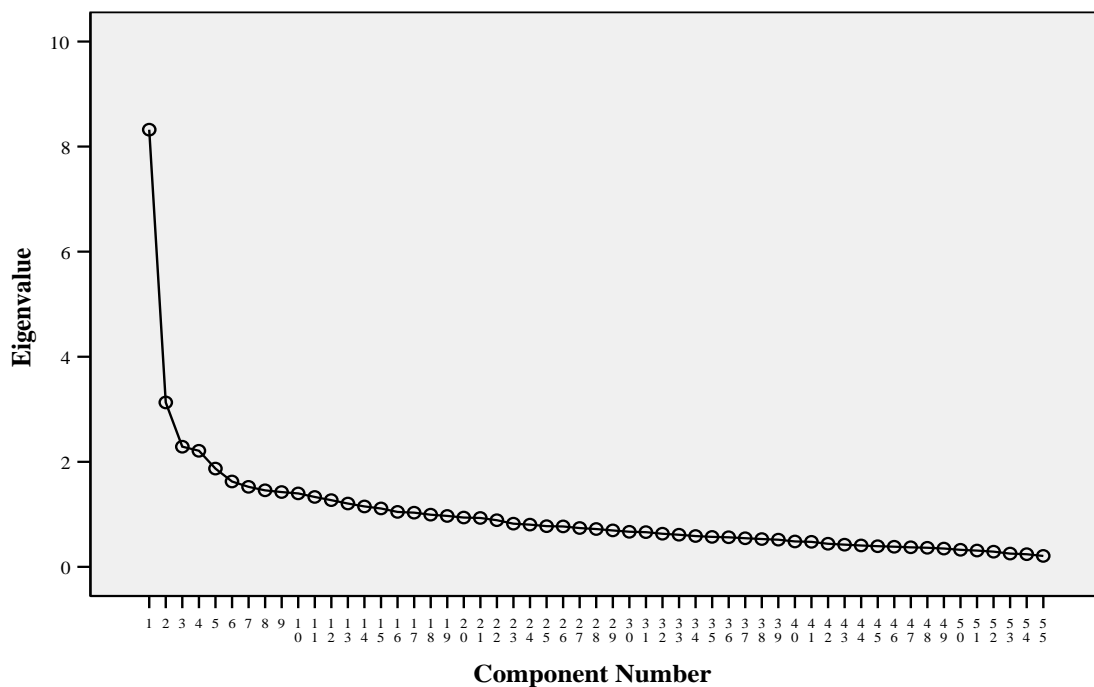


Figure 6: Scree plot of attitude scale

As too many components were extracted using the Kaiser criterion, a scree plot was used to extract components that explained much of the variance. From the elbow of the scree plot (see Figure 6), six components displayed much effect on the variances and the model was further rotated to extract the six components.

The model was rotated using a varimax orthogonal rotation and the rotation showed that the six components attributed 35.348% of the variance. As the component transformation matrix showed coefficients greater than 0.3, an oblique rotation using oblimin with Kaiser normalisation was done and yielded a matrix with coefficients lower than 0.3. The components were therefore not independent as the correlation was not strong. The attitude components are shown in Table 12 below:

Table 12: Attitude components.

Factor	Component	Items	Mean		
			Total (n=358)	Female (n=167)	Male (n=191)
1	Career	29, 35, 6, 24, 34, 12, 53, 17, 5, 18	4.17	4.08	4.25
2	Interest	54, 41, 30, 47, 48, 38, 36, 45, 32, 60, 23, 22, 28, 40, 44	3.94	3.89	3.98
3	society	9, 14, 3, 20, 16, 13, 26, 52, 59	4.31	4.23	4.38
4	Gender	55, 8, 43, 51, 57, 49, 31, 25	3.55	3.66	3.43
5	Science	39, 42, 15, 46, 4	3.46	3.50	3.41
6	Curriculum	11, 1, 56	3.93	3.90	3.95
Overall mean			3.89	3.88	3.90

The student's views towards technology appeared to be moderately positive as shown by a mean of 3.89 (see Table 12) but they had shown an understanding of the relationship between technology and society (mean-4.31). They also strongly viewed technology as a future career (mean-4.17). A further analysis of variance (ANOVA) showed that gender had no significant influence ($p > 0.05$) on their attitudes towards technology in over 60% of the items.

6.4.2.2 *Concept scale*

The last part of the questionnaire was a concept scale and it comprised 31 questions with options: agree, don't know and disagree. Cronbach's alpha

reliability coefficients for PATT studies conducted in New Zealand, the Netherlands, Poland and Kenya, among other countries, were 0.89, 0.74, 0.71 and 0.61 respectively. This study reported a Cronbach's alpha coefficient of 0.636 which is below the recommended cut off point of 0.7 (de Vaus, 1999; Lewis-Beck, et al., 2004). The instrument tested in this study contained 31 items as it was a composite of other PATT studies. Only three items had low corrected item-total correlation and these were deleted leaving the model with 28 items for further analysis. The deleted items are shown in Table 13 below:

Table 13: Deleted concept items

4	Technology has little to do with our energy problems.
16	Working with your hands is also part of technology.
26	Technology has always to do with production.

A Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of Sphericity (BTS) were computed to check the factorability of the model. Despite low internal consistency, the KMO measure of sampling adequacy and the BTS revealed the factorability of the model as it reported a KMO of 0.639 and a significant BTS ($p < 0.05$). The KMO is just above the recommended 0.6 (Kaiser, 1974; Pallant, 2007)

Factor analysis of the concept scale

After a PCA, 11 components with eigenvalues greater than 1 were extracted and these explained 57.36% of the variance.

Scree Plot

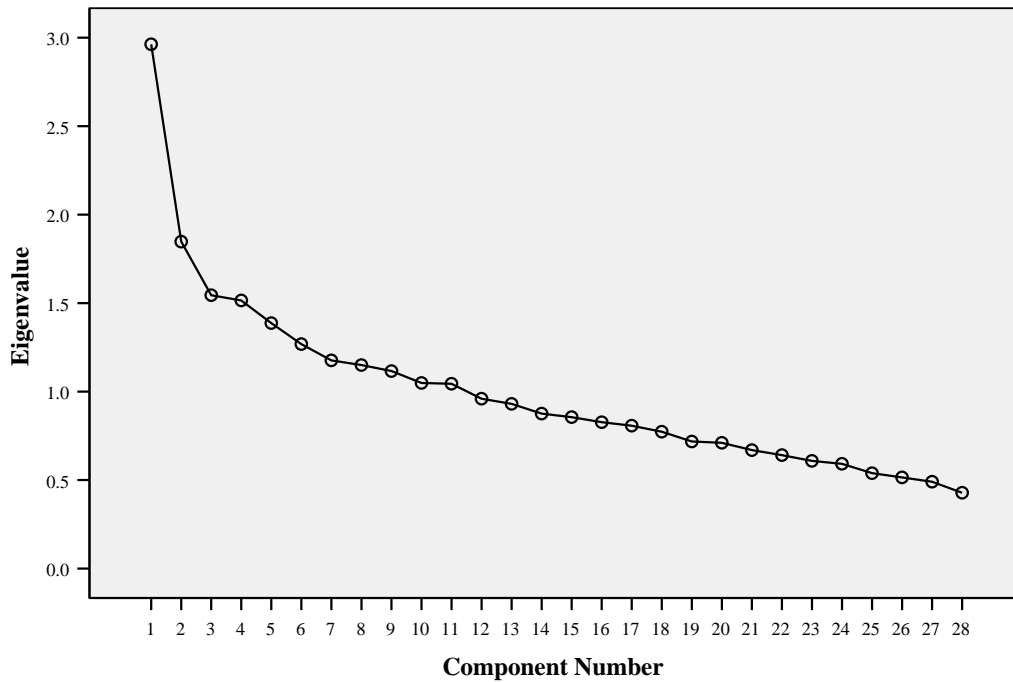


Figure 7: Scree plot of concept scale

After examining the scree plot (see Figure 7) and the table that explained the total variance, 4 components were selected for an orthogonal rotation. These components had heavy loading on total percentage variance and there were also 4 elbows in the scree plot. After a varimax orthogonal rotation, the 4 components explained for 28.11% of the total variance. As the component transformation matrix showed coefficients greater than 0.3, an oblique rotation using oblimin with Kaiser normalisation was done but failed to provide any results. A promax oblique rotation was applied and confirmed that the components were not strongly correlated. The components of the concept scale are therefore shown in Table 14 below:

Table 14: components of concept scale

Factor	Description	Item Number	Mean			
			Total (n=358)	Female (n=167)	Male (n=191)	Mean variation
1	Science and technology	2, 8, 9, 31, 15, 18	0.81	0.78	0.83	0.05
2	Social effects of technology	17, 20, 13, 22, 7, 10, 14, 28, 21	0.60	0.58	0.63	0.05
3	Techniques and skills	3, 11, 19, 12, 25, 29, 30	0.46	0.45	0.47	0.02
4	Hardware	24, 6, 1, 5, 23, 27	0.31	0.30	0.31	0.01
Overall mean			0.54	0.53	0.56	0.033

The students' views as depicted in Table 14 show that they hold some understanding of the concepts of technology as they were able to indicate an accurate concept in 54% of the questions. However the students appeared to hold a much better understanding of the relationship between science and technology (81%) while they maintained their stance where technology was associated with hardware, computers and machines (31%). A further analysis to determine any influences of the students' views showed no significant differences by gender ($p > 0.05$) as also shown by the negligible mean variations in Table 14. Other studies have shown significant gender differences (Burns, 1992; de Klerk Wolters, 1989; Volk & Yip, 1999) but the results in the current study may be attributed to increased girls' access to education.

Overall, the students' attitudes towards technology were moderately positive but the conceptualisation of technology by few of the students was restricted to viewing it as things and hardware. With these outcomes in mind, the teachers' reflections of the PATT results focussed on remedies to develop pedagogies that would help enhance students' attitudes and conceptualisation of technology.

The professional development also included a PATT model development and the results were used to help teachers build their understanding of technology and how students conceptualise technology. While the model showed students positive

views with no gender divide, the PATT was effectively used as a professional development tool. Through a discussion of the PATT results, teachers scored the importance of technology learning programmes designed in the student's own world.

6.4.3 Teachers' reflections of the PATT Results

Reflections of the PATT results involved that teachers had a thematic understanding of the questionnaire items and reflected on the implications of the students' responses on teaching and learning. This was achieved by going through all the questionnaire items against the frequencies of the students' responses. The results of the discussions showed the teachers' understanding of technology; students' limited knowledge about the nature of technology and the need for appropriate pedagogy and actions for learning technology and deconstructing stereotypes among teachers, students and the society in general. The discussions are described below.

After going through all the questions, the teachers said that the discussion helped them to recognise technology as a broad learning area as shown by a cross range of concepts covered in the PATT instrument. Discussing the results therefore helped them to develop understanding of further technological concepts, processes and learning approaches than what they had learnt during the professional development workshops. It was therefore suggested that technology should be the focus of the curriculum to help students acquire a wide spectrum of technological concepts, processes and capabilities. The students had also shown a lot of interest in the subject as depicted in the PATT results discussed above.

Technology is a broad subject... It encompasses many things and in fact I feel technology should be a core subject, from which other subjects can be derived now. So technology should be the centre or focus of learning in schools in Malawi. (Didi)

The teachers also thought that the discussion helped them to learn students' views about technology and the need to develop appropriate technology programmes and pedagogy for both male and female students to reinforce their confidence.

This was in light of the gender disparities in subject choices as shown in Table 10 which was attributed partly to lack of confidence in their own capabilities.

...I think we should encourage them by starting with little things, technological little things that everybody should be able to do regardless of gender or ability. So, we should put them all on the same platform and try to move along at the same pace. When they see things working, confidence will begin to build. (Didi)

Some students find it difficult to use machines leading to their negative attitude and therefore they need thorough motivation to develop their interest in machine work. (Zagwa)

We need to deal with their mindset for them to understand what technology is all about. That may help enhance their interest as shown in the PATT results. (Chiipira)

The teachers therefore appeared to suggest that teaching should emphasize coaching and sensitizing the students on the practical relevance of the subject so as to motivate them to learn and begin to enjoy working with machines. The teachers' also considered cognitive apprenticeship as an appropriate theory that can help students in learning technology and also gain confidence in doing technological activities.

It seemed that societal beliefs and stereotypes may have affected both boys' and girls' choices of learning subjects as most of the girls opted for home economics while most boys were learning technical subjects. For example, the PATT data showed that only 74 (53 girls and 21 boys) out of 358 students (21%) were learning home economics while only 31 students (nine percent, 30 boys and one girl) were learning technical subjects (see Table 10). Policy related to student placement in streams was seen as a root cause for the imbalance. The teachers also said that while there will be a need to review the policy, the establishment of technology clubs was viewed as a measure that would help support students interest in technology programmes and careers. The technology club would also help develop messages and programmes to deconstruct beliefs that associate gender with some skills, knowledge or careers and for society to appreciate that

both boys and girls can become car mechanics or operate a computer or that they can all do any technological job.

The teachers also spoke about the implications of the discussion. The teachers said that the results showed students' interest in technology that should be nurtured by offering them opportunities to broaden their understanding of technology as their responses showed limited knowledge of the nature of technology.

I still have the feeling that the students are really interested in technology. They have a feeling that it's part of them and that they cannot do without it. (Buli)

That's what I also think that the students appreciate the importance of technology. They know the need for technology but it looks they just don't understand clearly what technology is all about as they only associate it with computers and machines and that's what causes some negativity. But the passion is there for students to study technology. (Chiipira)

The teachers also indicated that the discussion was helpful as it provided them an understanding of the students' views, which would be important for planning teaching and learning of technology related programmes. They all considered the discussion as helpful since the students' views highlighted the need for developing learning materials, tools and pedagogical approaches that take into consideration the students' own world and knowledge of technology.

Obviously, it will indeed help us to approach the subject especially the technical subjects from a different angle. We have learnt how the students feel about our subjects. Some actually feel that we give them an impossible, boring subject which they thought it was just supposed to be an extra curricula activity, but we force them to do it as an examinable subject. Yea, it's food for thought, as we have seen how to approach technology to enable change in students' perceptions and practices. (Zagwa)

Yeah, I think, as for me, the discussion has been fruitful in that we have known the students' side - that they are interested in technology and when we see them running away from technical subjects, perhaps we should check ourselves; our approaches towards teaching the subject. Probably we are the ones scaring them. But otherwise, the students are interested to study technology. (Buli)

... after going through the PD, our teaching has changed in that we usually try our best to use the technological pedagogy that we learnt in the PD as opposed to the shouting we used to do before the workshops. (Papsya)

The teachers also said that there would be need for an integrated and flexible approach to the teaching of technology as the current curriculum restricts teaching and learning to drilling students to pass examinations. This is further complicated by the examination-based syllabi that teachers have to use in the schools. Therefore, the approach may require redefining the teaching and learning practices to reduce emphasis on examinations and focus more on developing students' technological capabilities. They suggested the involvement of other subject teachers such as science, social studies, arts and home economics to help enhance implementation of technology once it becomes a learning area. However, the teachers understanding of the concepts of integration and flexibility were not very clear. Further discussions and research on how such concepts can be incorporated in the teaching and learning of technology would help enhance their understanding of integration and flexibility.

6.5 Summary of findings

The results of the study demonstrated a shift in the teachers' perceptions towards technology and technology education. After the professional development programme, teachers displayed enhanced understanding of technology and they also attempted to implement pedagogies for enhancing student technological capabilities. The shift may therefore be attributed to the professional development programme through its focus on social cultural frameworks complemented by the use of the PATT results as a tool for teacher learning. Findings of the study are therefore summarised below.

- The teachers' knowledge of the nature of technology had shifted from their narrow concept to viewing it as a human activity for solving problems that address personal needs and those of society and the environment
- The professional development helped improve teachers' technological pedagogical knowledge but their practices were still influenced by their traditional beliefs and assumptions about student outcomes.
- Innovative use of the PATT instrument as a professional development tool assisted teachers to expand their knowledge of technology and technology education.

The exploration of teachers' existing views had shown limited knowledge of technology and technology education largely as a result of their existing beliefs and practices that focussed on technical know-how or skills development. The teachers associated technology with making, things and computers while technology education was viewed as learning how to make things and use computers. After a professional development programme that took into account those beliefs and practices, the teachers demonstrated an enhanced understanding of the nature of technology. Their new position included the realisation that technology was a human activity in relation to solving problems to address personal needs and that of society and the environment.

Discussion of the teachers existing practices had shown general pedagogical knowledge and a lack of pedagogy for imparting technological processes and capabilities. They had shown knowledge of design and problem solving but their approaches focussed on skills development for production of artefacts. Teaching practices after the professional development showed the teachers' attempts to implement technological pedagogical practices. The teachers attempted to employ pedagogies to promote students' thinking and reasoning through cooperative learning frameworks although they still needed more knowledge and creativity for developing suitable instructional strategies that give students opportunities to explore their own world.

The professional development was an effective model as it built on prevailing contextual factors and teacher learning that was focussed on social cultural frameworks. Teachers supported each other towards developing new concepts and they were also supported through teacher-researcher meetings, workshops interspaced with classroom observations and reflective discussions. The model helped to change the teachers' views but they needed more support and strategic contacts to strengthen their teaching practices and prospects to implement pedagogies which promote student learning of technological processes and capabilities. Wide technical teaching experiences, college background, beliefs, curriculum and policy assumptions posed a challenge for teachers to change and adopt new practices.

A PATT model for Malawi was developed and it was effectively used as a tool for professional development that helps to build teachers' understanding of students' conceptualisations of technology. Teachers reflected on the PATT results which helped them develop an understanding of the compactness of the PATT instrument in highlighting students' needs and expectations for learning technology. With that understanding, the teachers were now in a better position to design instruction and programmes meaningful for students' learning of technological processes. Scaling up the model would therefore help to reach out to many teachers and further understand students' views at a national level.

The findings and their implications will be discussed in Chapter Seven below.

CHAPTER SEVEN

DISCUSSION, CONCLUSION AND IMPLICATIONS

7.1 Introduction

Internationally there has been concern about the direction of technical education and how it is positioned in schools, leading to the development of learning of broad-based technology education (e.g. de Vries, 2009; King & Martin, 2002; Seiter, 2009; Williams, 2009). This has also been the case in Malawi where the curriculum has had a strong focus on skills development based on the colonial-based industrial arts and craft. Lately there has been a call for enhancing technological literacy of students (Ministry of Finance, 2006; National Economic Council, 2003; National Research Council of Malawi, 2002), yet little support has been provided for teachers to achieve this goal. This section discusses the findings from an investigation of Malawi secondary school teachers' and students' perceptions towards technology and technology education. The focus of this study was to explore the influences of, expand the teachers' (and students') ideas about technology and technology education and also to enhance teaching practices. In order to capture a more holistic understanding of such influences, an interpretive research methodology (Cohen, et al., 2005; Donmoyer, 2006) was adopted and the teachers were involved in in-depth, one-on-one and semi-structured interviews, group discussions and classroom observations both before and after professional development workshops. This helped to collectively construct the social reality surrounding the teachers' existing beliefs and teaching practices and how to change those practices and beliefs.

Three specific objectives (see section 1.4) were developed and these related to the exploration of students' views about technology and implications on teacher learning; exploration of teachers' perceptions towards technology and technology education; and also enhancing teachers' technological pedagogical knowledge and teaching practices.

The study was undertaken in three secondary schools: Kabula, Mudi and Shire and two teachers from each of these schools participated in the study after their

informed consent was obtained. The teachers also took part in a professional development programme that was informed by the teachers' own existing views, beliefs and practices and international best practice in professional learning and development. A school-based professional development also included discussions of PATT results and these helped teachers' conceptualisation of teaching and learning in technology. Teachers also reflected on how the professional development changed their views about technology and technology education and they recommended scaling up the programme for more teachers to benefit. Three key findings arose from the study, and these are:

- The teachers' contexts and the stance on the goals of the traditional curriculum influence their understanding of the nature of technology and technology education.
- Enhanced technological pedagogical knowledge promotes teachers' innovations to develop and implement technological activities.
- Professional development underpinned by social cultural frameworks of learning is an effective model when it also incorporates teachers' beliefs and experiences.

The findings of the study are discussed in sections 7.2 to 7.5 and section 7.6 discusses the conclusion and implications on teacher development and training; curriculum and education policy reviews and reforms; and implications for further research.

7.2 Enhanced teachers' knowledge of the nature of technology and technology education

The focus of this study highlighted critical perspectives of incorporating teacher beliefs in professional development programmes that aim to enhance the teachers' knowledge of the nature of technology and technology education. The results reported in this study showed enhanced views of teachers about the nature of technology and also enhanced understanding of teaching, learning and curriculum issues related to technology. However, their views about technology education were restricted to associating it with acquiring procedural knowledge. They also

viewed students' occupations after school as important factors for teaching and learning technology while society and environmental factors were less considered. Therefore, teachers' perceptions and beliefs about content, pedagogy and learner outcomes have been shown to influence curriculum processes and teacher learning in professional development programmes (e.g. Compton & Jones, 1998; McRobbie, Ginns, & Stein, 2000).

Exploration of the teachers' existing views showed a wide range of experiences and beliefs in the rationale of the technical curriculum underpinned around skills development or technical training for manufacturing related occupations. The teachers showed a clear understanding of this rationale and they also showed awareness of problems impacting on its implementation and remedies that could help to address the gaps. The rationale of the curriculum mirrored pre-colonial contexts and ideologies reinforced by political developments leading to the nation's quest for poverty alleviation and localisation of posts in industry and government - and the teachers supported such policies. Malawi's visions for economic growth and development (Ministry of Finance, 2006; National Statistical Office of Malawi, 2005) have also emphasised the need for programmes that may help to curb poverty and youth unemployment. However, low uptake of technology was recognised as a hindrance and hence the suggestion for learning that enhances student technological literacy. Such policies have existed for over five decades, and remain incorporated into current policy guidelines (Ministry of Education and Vocational Training, 1973, 1985; Ministry of Education Science and Technology, 2008). Although the goals of the curriculum have been described as mythical and expensive (Akyeampong, 2005; King & Martin, 2002; Msiska, 1994), the teachers here still viewed the programme as attainable but they suggested a review of pedagogical and technological practices to include thinking skills for students to be able to solve problems.

The teachers' contexts and experiences therefore, and their stance on the goals of the technical education curriculum influenced their views about technology and technology education. They believed in students acquiring production skills for their own self sustenance but they also suggested curricula innovations such as incorporating learning for thinking through problem solving, design, projects and

work-based learning. However, their discussions of such modes of teaching and learning showed a focus on skills development as their innovations centred on students making things and repairing pieces of furniture. Their views about technology as described in Chapter Four were limited to considering it as a purposeful human activity related to designing and making things, solving basic problems and use of modern hardware. They associated technology with processes and things they also considered as core learning aspects in technical education such as learning about the science of materials, use of hardware and also craft skills related to design, production and repairing furniture.

Technology has developed from a narrow concept that focussed on craft skills which were also emphasised by the teachers in this study. The scope of technology internationally, over the past two decades has broadened to take into account societal aspects and more cognitive, conceptual and epistemic dimensions of technology (de Vries, 2006). Teachers in Malawi therefore, needed support to develop a shared understanding and to view technology as how people modify the natural world through a variety of processes and diverse forms of knowledge to satisfy varying societal needs and wants (Dakers & de Vries, 2009; Technology for All Americans Project, 2000). The teachers' constant reference to technology as advancement, improvement or change may have implied their associating it with values, but they also needed an understanding of the broad relationship between technology and society beyond the mechanics of design projects and problem solving. Visible links commonly cited by the teachers only involved society's use of new gadgets such as computers and machines. Teaching technology in such a context therefore, requires a change in teachers' attitudes, beliefs and understandings of technology for them to shift from thinking of technology as hardware or things to more egalitarian, holistic and broad-based approaches.

As a consequence of their limited perceptions of technology, the teachers viewed technology education as being all about hands-on training on how to use technology which included workshop processes, learning about the science of materials and solving problems such as repairing pieces of furniture. While the socio-economic indicators and technological developments in the country contexts may have influenced the teachers' views, their experiences, professional

background and factors related to students' occupations after school were critical in their understanding of technology and technology education. The teachers viewed technology education as an important part of the curriculum that would help students develop thinking and reasoning to solve problems for their own poverty alleviation. The teachers' views were consistent in that their attempts to distinguish technology education and technical education showed that they were seen as not completely distinct areas of study. That meant they considered the curriculum as already offering learning in technology which to them just required a review of pedagogical practices to include thinking skills for solving problems. However, the curriculum already included learning of design leading to project activities for students' final year assessment and the teachers had shown they had design knowledge but their pedagogical knowledge was limited to skills drilling. It was also seen that while the teachers' design and project activities focussed on assessment, this may have been influenced by the entire system as performance is examination based. Therefore teaching concepts of design and projects as learning activities required teachers' further analysis of the theoretical and pedagogical basis of the methodologies.

The teachers linked learning in technology to economic and social factors. Existing policy and curriculum materials were also developed with a focus on the same goals and beliefs although schools had no control over the conditions outside the classroom. Therefore programmes to transform their beliefs required strategies that would convince them of the need for such change and benefits of adopting broader views of technology and technology education. Unless their reasoned beliefs are incorporated into such programmes, gaps between policy and practice may not be easily overcome. For instance attempts were made to establish science and technology as a core learning area, but it was resisted as a section of society believed the content lacked generality for tertiary learning and that teachers were not supported to teach it. Similar challenges may also resurface if teachers do not develop an adequate and shared understanding of technological content and its pedagogy. Studies in England, Scotland and New Zealand (Jarvis & Rennie, 1996; Jones & Carr, 1992; Mittell & Penny, 1997), have also highlighted limited views of technology held by teachers, arising from differing beliefs in the meaning of technology, its content and teaching methods. While the

beliefs may have impeded implementation of the technology curriculum even in countries where technology was an established learning area, understanding and then incorporating such beliefs in foundational stages of curricula development processes, including professional development programmes, may be an alternative way to mitigate such hurdles and improve teaching practices (Sherman, Sanders, & Kwon, 2010).

In an attempt to develop broader notions of technology and technology education, teachers were involved in a professional development programme that took into account their existing beliefs and practices. The model for the professional development was reported in Chapter Six and the teachers' reflections reported in Chapter Seven. The findings after the intervention showed enhanced and positive views about technology that resulted from a model that focussed on social cultural frameworks of teacher learning. The teachers associated technology with processes for manipulating knowledge and skills to produce artefacts that meet human needs. The teachers also considered technology education as education where students acquire information, skills or technical know-how to design and make things towards solving personal, societal or environmental problems. One teacher further suggested the use of collaborative learning approaches that were viewed as supportive to students' thinking.

The teachers' reflections of technology and technology education as influenced by the professional development suggested a shift. The teachers' beliefs or theories related to the traditional technical subjects appeared to shift towards a curriculum that promotes learning of broad notions of technology. However, the emphasis on skills or technical know-how has been the norm even in societies with established technology cultures (e.g. Gibson, 2009; Mittell & Penny, 1997). In some countries, for instance Botswana and Scotland (Dakers, 2006; Weeks, 2005), technology is offered in primary and lower levels of secondary school while the senior levels still offer traditional practical craft subjects as a way of preparing the students, (the less academically able in the case of Scotland) for life after leaving school. Expectations and beliefs of after school effects have largely influenced decisions on curriculum content, nomenclature and segmentation of levels for offering technology. It is also seen that where beliefs appear to have influenced reluctance to embrace broader notions of technology, there have been disjunctions

leading to suggestions to revert to the old traditional technical subjects (e.g. Mittell & Penny, 1997). The study therefore incorporated the teachers' beliefs and expectations in a professional development model that recognised teachers as professionals with rich experiences, and that formed a basis for teacher learning of new ideas about technology and technology education.

The teachers also developed confidence and engaged in discourse to further understand some concepts in technology such as cultural historic perspectives, the distinction between design and problem solving and pedagogies that emphasise project-based learning. They also argued for in-service and pre-service programmes and teacher networking to incorporate learning in communities of practice or work-based learning as means of developing teachers' technological practices. Although studies reviewed in Dakers and de Vries (2009) showed teachers' reluctance to engage in the hermeneutic and conceptual dimensions of technology, the teachers being interactive and discursive in this study showed they had developed deep knowledge of fundamental theories that helped shape their further understanding of the philosophy of technology.

While this study attempted to address gaps in the teachers' understanding of conceptual, epistemological and theoretical underpinnings of technology, a shift towards addressing the socio-technical processes will require further professional development with consistent follow-up, support and reflective programmes. Because of the interconnectedness of beliefs and experiences, Stein, Ginns and McDonald (2007) suggested that significant change may also be a long term process resulting from further experience of trying and testing new concepts in practice towards developing sophisticated views of teaching and learning technology. Thus the teachers need to develop, over time, a shared understanding and beliefs about the nature of technology for them to conceptualise it in a manner that will lead to concise student acquisition of technological capabilities. Inconsistencies in their conceptualisation of how and what to teach may further widen the gap between policy and practice, thereby reducing opportunities that may help students acquire a more accurate, informed and advanced level of technological literacy. The study has therefore shown that successful professional development programmes incorporate existing beliefs and practices, as these influence teachers' understanding and development of broader views of

technology and technology education. Key components and outcomes of the professional development model are highlighted in section 7.5.

7.3 Improved teachers' technological pedagogical knowledge and practices

The study revealed that while subject content knowledge is critical towards planning technological activities, technological pedagogical knowledge particularly improves the teachers' abilities to implement those plans. Hence, professional development programmes that enhance teachers' knowledge about how to teach and how students learn technology may help improve teaching practices in technology (see also Daugherty & Custer, in press; Rohaan, Taconis, & Jochems, in press; Sherman, et al., 2010).

In order to understand how the teachers' beliefs impacted on their practices, teachers' existing practices were explored through interviews, teacher-researcher meetings and classroom observations followed by reflective discussions. A similar process was also implemented whereby classroom observations were interspersed with professional development workshops to enable teachers' immediate trial and reflections of concepts learnt in the workshops. An analysis of the data on their existing practices revealed the teachers' broad technical content knowledge and technological practices were restricted to production techniques, design-make-appraise concepts and a vast knowledge of graphical communication. They even expressed concern for more technical knowledge related to workshop machine operations and maintenance which only reinforced their beliefs in skills development for manufacturing occupations.

Despite holding general pedagogical knowledge, teaching practices were impacted by resources constraints and teachers' limited technological pedagogical knowledge and practices. The teachers displayed knowledge of design, problem-solving, project and collaborative teaching styles but focussed more on skills development although that could be attributed to contextual factors and a lack of social mediation. Even though the focus was on skills development, learning also centred on students passing examinations such that schools that failed to provide adequate resources for learning were reportedly able to buy materials and keep

machines running for students' practical examinations. The teachers were therefore implementing the curriculum in extremely difficult conditions but they had shown innovations to support student learning of basic skills. Behaviourist teaching styles were used, leading to passive learners who consequently found it difficult to gain any meaningful learning of technology.

In order to assist the teachers to develop skills and knowledge necessary for planning technology programmes in their teaching practices, the teachers participated in a series of workshops that covered curriculum, social issues and concepts related to teaching and learning technology (see the professional development model in Chapter Six). The teachers were followed up in their classrooms to check whether they were able to implement any concepts learnt in the workshops. The findings revealed that teachers had improved their technological pedagogical practices as they attempted to implement programmes to support student learning of technology. They had shown knowledge and capabilities to incorporate learning that uses authentic problems, student collaboration in completing projects and also learning in local communities of practice (for example, tinsmith). Location of the schools was of no consequence as even teachers from a rural school were able to plan more innovative approaches and included student activities essential for learning technology. Unless teachers develop appropriate beliefs and robust knowledge of the pedagogies suitable for teaching and learning broad based technology, traditional practices may be difficult for teachers to drop. However, teaching practices may be enhanced by supporting teachers to look at change positively by involving them in reviewing their own practices through professional development programmes. The programmes may target teachers developing their own understanding of new concepts and allowing them space to implement concepts they deem fit for their context and setting and providing support in implementing areas they consider difficult.

7.4 Building teachers' conceptualisation of learning in technology through PATT data

While research has linked technology to its Greek origins, the early civilizations' and early humans' use of technological artefacts (Basalla, 1988; Dakers & de

Vries, 2009), much debate that has developed a deeper understanding of learning technology may also be attributed to the PATT studies. Reflections over the relationship between technology and society that emerged in the post-world war era and the industrial and space revolutions also had an influence on the nature of technology adopted for learning in schools. However, the studies informed curriculum development and learning approaches in a number of countries to shift from an industrial arts-based curriculum to a broad-based technology education with a focus on critical pedagogy and incorporating in learning programmes students' own world views about technology (Dakers & de Vries, 2009; de Vries, 2009). While the PATT research (Raaijmakers, et al., 1987; van Rensburg, et al., 1999) influenced curriculum developments, it also added knowledge on educators understanding about students' dispositions and how to shape them. The discussion of the results therefore helped the teachers appreciate the students' perceptions towards technology for planning appropriate programmes or classroom activities. An understanding of the students' intuitive ideas of the nature of technology (Compton & France, 2007), helps teachers situate learning in the students' own world. The PATT data were therefore used as a tool for enhancing technological classroom practices, unlike in other research studies where it mostly informed technology education curriculum design and its implications (Burns, 1992; Raaijmakers, et al., 1985).

This study employed an innovative use of PATT data as a tool for professional development and, as a pioneer, it serves as a model that can be adopted for in-service and pre-service teacher education and development. The process involved developing a thematic understanding of the questions in relation to the descriptive statistics of the data that showed students' views, interest and their attitudes towards technology. The teachers debated the meaning of the students' responses to the questionnaire and how that may help change policy and practices that prevent both boys and girls from learning technology subjects. Chapter Five reported on the results of the PATT survey and teachers' reflections on the findings were reported in Chapter Six.

The analysis of the data revealed students' positive interests in technology but their concepts of technology were restricted to things, hardware and computers. However, their interest seemed to focus on technology hardware as they had

shown minimal enthusiasm in learning technology as a curriculum subject. The students had also shown an understanding of the link between technology, society and also their future careers. The students' views could not be attributed to learning in technology-related subjects as less than a quarter of the students were involved in traditional technical subjects –metalwork, woodwork, technical drawing and home economics. Their concern about society appeared to be a source of their inspiration as they had shown views towards a technology led society and their views also reflected society's goals for technology-led economic growth and development (Ministry of Finance, 2006).

Overall, the students' attitudes towards technology were moderately positive but their conceptualisation of technology was restricted to viewing it as things and hardware. Although Malawi lags behind technologically and the curriculum emphasises crafts skills, the results are not different from outcomes of similar studies conducted elsewhere (for example, Burns, 1992; Solomonidou & Tassios, 2007). Following PATT studies and other influences and motives, many countries established technology as a learning area to broaden students' conceptualisation of technology and enhance their creativity and innovative capacities (de Vries, 2009; Parkinson & Hope, 2009). Taking advantage of students' interest for a curriculum that incorporates technology, students would therefore benefit from programmes that enhance their attitudes and also broaden their understanding of technology through teaching and learning that emphasises technological literacy. Malawi should therefore shift from the colonial, prescriptive craft based curriculum to a broad based technology education in order to enhance student technological literacy. With these findings in mind, the teachers' reflections of the PATT results focussed on remedies to develop pedagogies that would help enhance students' attitudes and conceptualisation of technology.

Harnessing that interest and expanding their conceptualisation of technology therefore requires teachers that know students' expectations and beliefs and how to plan instruction which addresses that same need. While the context would present implications on the teachers' abilities to implement technology programmes, their pedagogical knowledge and practices are fundamental to developing suitable learning activities from the students' perspective. The discussion of the PATT data provided a test that can shape the teachers'

understanding by knowing the perceptions that students hold about technology and how to address issues of policy on streaming by gender, subject preferences and stereotypes. What appeared profound was that schools seemed to have recognised that there was no justification to restrict opportunities for female students to learn technology when the students themselves do not see any obstacles. While schools seemed to have changed their streaming policies to allow both female and male students study subjects of their choice, it was still observed that more female students were studying home economics while more male students and fewer females were enrolled in technical subjects. Society stereotypes are therefore still persistent that force girls to shun male dominated disciplines and that can only be addressed if technology is popularised not only among learners but also the entire society. Issues of equity in technology should not only be left to schools to address, it must begin from general society.

Engaging teachers in understanding the data provided them with an opportunity to further reflect on their own knowledge of the nature of technology and technology education since the PATT instrument consisted of some factors that best describe the nature of technology and technology education. The teachers themselves recognised the instrument as containing vast and rich aspects of technology helpful for understanding and developing appropriate teaching and learning activities. The discussion also revealed the teachers' knowledge of technology as they were able to critique the students' views in a manner that reflects broader views of technology. It was therefore revealed that the discussion of the PATT data helped teachers to share some strategies to deal with motivating students' interest towards learning technology, addressing the gender divide, and designing instructions that would help students develop the concepts of technology through use of activities and experiences with a bearing on the students' own world views. Appropriate technological pedagogy was therefore viewed as an alternative to addressing varying interests, values, learning styles of students and stereotypes that influence subject choices. It may therefore be concluded that the PATT data were an effective tool in the professional development as it helped teachers to expand their knowledge of technology and technology education.

7.5 An effective professional development model

This study reported an effective professional development model that helped to develop teachers' perceptions towards technology and technology education based on the notion that perceptions influence conceptualisation of teaching and learning technology. Teachers' having perceptions consistent with the philosophy of technology is critical for implementing technology, particularly in an education system founded on the beliefs and assumptions of a comprehensive curriculum. Key characteristics of the model, therefore, included:

- An understanding and incorporating the teachers' beliefs and practices into the professional development programme for teachers to be able change such beliefs and adopt broader views of technology.
- Encouraging collaborative learning in their schools for teachers to share knowledge, their own experiences and that of others, and planning presentations of their interpretations of selected scholarly readings.
- Teachers learning about technology from the perspectives of students using PATT data that was seen as an effective professional development tool.
- On-going reflections and support to enhance teachers' capacities to reflect on their own experiences for purposeful change.

The model therefore involved establishing the needs and planning that included exploration of beliefs and practices to inform the design and implementation of the professional development. There were three workshops interspersed with teaching practices that allowed teachers to discover new concepts through readings and to try the new concepts, and to reflect on their own learning. Teachers therefore reflected in action by putting into meaningful practice acquired knowledge and skills.

As professional learning is viewed as a social enterprise (Glazer & Hannafin, 2006), the professional development was effective as it took into consideration social cultural frameworks and adult learning theories characterised by teachers'

active learning and participation towards developing workshop agendas. As beliefs and experiences tend to shape change and teacher learning and practices (Dow, 2006a; Sherman, et al., 2010; Stein, et al., 2007), the professional development model incorporated their existing views as they also contributed ideas towards setting workshop targets which primarily focussed on improving their practices for meaningful student learning. Other studies (for example, Lotter, Harwood, & Bonner, 2006) also suggested that engaging teachers in identifying key learning issues is an effective professional development strategy. As adult learners, the model helped teachers develop concepts of technology on their own volition through scholarly readings and sharing that knowledge with each other in the schools and during the workshops. While the teachers supported each other, the strategy may also have helped teachers to develop their own capacity for self-guided enquiry for their lifelong learning.

The model for the professional development in this study was underpinned by social cultural frameworks of learning that also enhanced teachers' reflectivity on their own practices and sharing knowledge and experiences of other technology teachers. Research has shown that many professional development programmes tend to be curriculum-based or design-based as in pre-engineering programmes, while other programmes focus on specific instructional practices to increase chances of teachers' classroom use of those practices (Daugherty & Custer, in press; Desimone, Porter, Garet, Yoon, & Birman, 2002). It was also noted that the focus of most professional development programmes has largely been on technological praxis, techniques, pedagogical content knowledge and also classroom and assessment practices (Jones & Moreland, 2004; Rohaan, et al., in press).

On the other hand, Sherman et al. (2010) for example, suggested sufficient engagement of teachers allows them to go beyond the mechanics and content to address fundamental beliefs, philosophies and conceptions consistent with current thinking in technology. Dakers and de Vries (2009) also argued for perceptual reforms from a Weberian behaviourist pedagogy to more socially constructed, dialogical and humanistic pedagogical practices, but that could be achieved if teachers' beliefs in what counts as knowledge were adequately addressed. The professional development model reported in this study deconstructed the teachers'

traditional beliefs to adopt thinking and teaching practices suitable for teaching and learning broad-based technology education.

In order to change the teachers' perceptions from their behaviourist traditions, a professional development programme was therefore implemented to enhance their knowledge of the nature of technology and improve their pedagogical practices. It was organised in three phases with reflections informing activities in subsequent phases. The first phase included establishing needs through an exploration of existing views and practices which were incorporated in the workshop planning and implementation. The investigation of teachers' existing views and practices revealed teachers limited knowledge about technology and technology education attributed to the teachers' beliefs and experiences in technical education which had a strong focus on skills development for jobs and entrepreneurship. These views were also reinforced through observations of their teaching practices which revealed the teachers content knowledge and general pedagogy but limited technological pedagogical knowledge and practices. The second and third phases of the professional development included teachers exploring the nature of technology and technology education through workshops, collaborative projects and reflective discussions that also included teacher development of an understanding of student learning of technology through the lens of PATT results. The workshops were interspersed with teaching practices where teachers tried their newly acquired concepts. The model involved teachers in understanding the nature of technology through readings and preparing group presentations of their newly acquired views about technology. Their learning was further supported by group activities in instructional design and discussions of their reflections of their learning. Teachers were therefore engaged in sharing their beliefs and experiences, teaching practices where they implemented new approaches, discussions of PATT data where they developed an understanding of students' views and also reflections of their own learning during the professional development.

The professional development model was hence effective as it helped reshape the teachers' views and practices in teaching and learning technology. The model also helped to engage teachers to share knowledge, experiences and discourses related to the concepts of technology, thus leading to their development of scholarly

practices which should help them to further reshape their views for a better understanding of the philosophy that underpins technology.

The study therefore, resulted in a professional development model that helped to enhance the teachers' perceptions of technology and it also improved their conceptualisation of technological and pedagogical practices. Therefore, key outcomes of the professional development model reported in this study were:

- Understanding teachers' beliefs, experiences and existing practices is key to change and development of thinking and pedagogy that support learning in technology.
- Importance of allowing teachers develop their own democratic potential to learn, reflect and implement new concepts of technology.
- Learning technology from the students' perspective helps enhance chances of teachers developing and implementing instruction that focuses on students' world views about technology.
- Enhanced knowledge of the nature of technology and improved technological pedagogical knowledge influences teaching practices and increases teachers' chances of teaching technology that encompasses broader views.

Through its focus on social cultural frameworks and incorporating existing beliefs and practices, the model can be used in countries that may desire to shift from learning the traditional technical subjects to broad based technology education. The knowledge accrued from the study also supports processes that may lead to further understanding of the Science and technology policy for Malawi (National Research Council of Malawi, 2002) where restructuring of the technical education curriculum was seen as a strategic pillar towards establishing learning that enhances technological literacy critical for the envisaged technology-led economic growth and development.

The Ministry of Education in Malawi also streamlined professional development as a means of improving education quality (Ministry of Education Science and

Technology, 2008). Strategies included the institutionalization of continuous professional development of teachers for primary, secondary and teacher training personnel. In practice however, professional development of teachers in Malawi is often associated with upgrading of untrained primary school teachers and induction of teachers to new learning materials and curricula (Kunje & Stuart, 1999; Nyirenda, 2005). Technical teachers have never been exposed to such professional development programmes and the teachers cited a lack of curriculum review as a cause of such a gap. This study therefore opened a new chapter in the history of technology education and it accorded the teachers an opportunity to take part in a professional development programme, the first of its kind in their teaching career. With that context in mind, a professional development programme that helps sustain teacher learning may help support strategies that target improving quality and reshaping practice. Technology is also continuously evolving or being reconstituted (Dakers & de Vries, 2009). As such, teachers will need to upgrade their knowledge and practices to meet the new and challenging needs of teaching and learning technology.

7.6 Conclusion and implications

The study highlighted the importance of understanding teachers' beliefs and practices and incorporating such practices in professional development programmes that focus on developing positive perceptions towards technology and technology education. As adult learners, teachers' rich beliefs and experiences influence what and how to learn (Dow, 2006a; Timperley, et al., 2007). Incorporating social cultural frameworks of learning may therefore help teachers to learn from each other's beliefs and experiences, leading to enhanced knowledge of technology and technology education. This study helped teachers develop a broader understanding of the nature of technology and technology education using a professional development model that focussed on teachers developing their own concepts through readings of scholarly papers, learning from other teachers' experiences and through discussion of student concepts and attitudes to technology. Findings of the research revealed an effective professional development model focussed on social cultural frameworks of learning that resulted in teachers' positive perceptions of technology and technology education.

They had also shown innovations to implement technology as a consequence of their enhanced technological pedagogical knowledge. It is therefore concluded that enhanced knowledge of the nature of technology and improved technological pedagogical knowledge influences teaching practices and increases teachers' chances of teaching technology that encompasses broader views.

The teachers involved in this study held limited practices and views that were restricted to considering technology as things and hardware. The study helped teachers to shift their views and practices to consider technology and technological practice in its broad sense. While Malawi made varying attempts to promote learning of science and technology, implementation was marred by teachers' limited pedagogical knowledge base and resistance from some sectors of society that had problems with its content and philosophy. With an implementation of the model used in this study, teachers in Malawi can be supported to develop a more effective and holistic understanding of the nature of technology and technology education, knowledge about teaching and learning technology and curriculum and social issues in technology.

The findings of the study therefore, have implications for pre-service and in-service teacher training and development, policy change in relation to curriculum reviews and reforms in Malawi and other developing countries. There are also implications for further research that focus on developing knowledge and understanding among teachers on how to improve teaching and learning that enhances student technological literacy but which considers the context being targeted by the curriculum. The implications are discussed below.

7.6.1 Implications on teacher development and education

The study has shown implications for teacher development and training and also on the development of technology education scholars to further research and enhance teaching and learning technology. The teachers in this study had shown deep technical content knowledge and limited pedagogical knowledge consisting of traditional and behaviourist practices, both attributed to their college education and their lack of support in schools. This was also reinforced by their broad teaching experiences which influenced the teachers on how and what to learn.

Restructuring teacher education to focus on both content and pedagogy may therefore help teachers develop knowledge of techniques or content, pedagogy and self-efficacy for teaching the content in a meaningful manner. While there are many models of pre-service teacher education including didactic traditions (Darling-Hammond, 2006; Trotter, 2006), the emphasis in technology education should be on developing effective professional skills. The professional development model used in this study can be implemented to address any gaps in college education and to equip teachers with pedagogies that may help them link theory and technological practice.

The findings also show that teachers' understanding of students' conceptualisation of technology has implications for teacher learning and also developing a knowledge base about their learners. Incorporating programmes that involve PATT studies in both in-service and pre-service teacher training programmes may be a source for teachers' development of technological knowledge, students' conceptions about technology and how to support them to learn technology. Preparing teachers to be able to design and analyse school level PATT studies would help provide basic data for teachers developing a deeper insight for teaching and learning that addresses students' needs and expectations. Besides focussing on promoting students' technological capabilities, learning technology should also help enhance learners' attitudes and expectations and studies of this nature may provide useful data for understanding such factors. Therefore, innovations for scaling up the PATT model, including establishing a data bank covering a number of learner cohorts would help inform teaching and learning, teacher professional development and it may also help popularise technology as a learning area.

7.6.2 Implications on curriculum and education policy reviews

Findings of the study have implications for curriculum review and reforms suggested in Malawi's Vision 2020 and the Science and Technology policy for Malawi. Previous attempts to establish science and technology and also craft, design and technology failed as there were no mechanisms to support teachers' development of beliefs and pedagogy suitable for translating content into classroom practices. Teachers needed to develop a deep understanding of the

nature of the subject and appropriate theories that support learning of the content. While there seemed to be political exigencies (Faure, et al., 1972; King & Martin, 2002) to implement skills-based programmes that were deemed helpful for poverty alleviation, industrial growth and motivating students for further study in engineering, the motivations for a comprehensive curriculum excluded confounding factors such as teacher support and the context in which it was to be implemented. Curriculum review and reforms therefore need to address teacher professional needs before classroom implementation. The model used in this study worked with teachers to incorporate their beliefs and practices in a professional development programme that aimed at transforming those practices to adopt broader views that support teaching and learning technology. As there was no curriculum statement teachers developed concepts and knowledge of technology and technology education from sets of readings and workshop activities that prepared them to implement technological activities within existing settings. The professional development influenced teacher change of their beliefs and practices leading to their developing an understanding of critical pedagogy for students' development of technological literacy. Teachers' precise knowledge of the nature of technology and related pedagogy helps them to assist students develop a similar level of understanding of technology. Jones and Moreland (2004) had also shown that enhanced teacher pedagogical content knowledge results in enhanced student learning. It is therefore suggested that any reviews and reforms towards restructuring of the technology curriculum should involve teachers developing positive perceptions and sound pedagogy suitable for teaching and learning technology. Teachers with positive perceptions and a clear knowledge base of the nature of the subject will implement it in a manner that supports the goals of the curriculum and it may also help to minimise threats of curriculum withdrawal or implementing old traditions in a new subject (see for example, de Vries, 2009; Mittell & Penny, 1997).

7.6.3 Implications on further research

Considering the wide implications of the study discussed in this thesis, further research is recommended for, scaling up both the professional development model and the PATT model in Malawi. Given the reported teacher change in beliefs and practices as a result of the professional development, a study on a larger scale

would provide insight into processes for implementing technology that will take the context into consideration. The studies would also help generate knowledge and capacity to improve teaching practices leading to development of scholars able to develop their own classroom research to test newly acquired theories and pedagogy.

In conclusion, the study helped to explore and expand teachers' views and practices about technology and technology education and the capacity can be extended through further research. It has been shown that the teachers' beliefs, experiences and existing practices influence teacher learning of the nature of technology and technology education. However, collaboratively engaging teachers to learn from each other's beliefs and experiences helps them to actively participate and support each other in a professional development programme leading to their acquiring knowledge and new concepts about technology. It was also shown that besides content knowledge teachers need technological pedagogical knowledge to enhance their conceptualisation of meaningful teaching and learning programmes. It was also revealed that the PATT survey data can be an effective professional development tool to help teachers' understanding of students' interests and expectations necessary for designing instructional activities that suit the students' own world. In conclusion, it has been argued in this study that teachers can shift from traditional practices and beliefs if they are engaged in a professional development programme that focuses on social cultural frameworks of learning. Therefore, scaling up the professional development model will help teachers to develop positive perceptions towards technology and enhance their pedagogical knowledge necessary for implementing programmes that can promote students technological literacy. Enabling policy for implementing technology education in Malawi is clearly shown in Vision 2020 and the Science and Technology policy Malawi's. However, achieving the policy goals will not be easy unless teachers develop a shared understanding about the nature of technology and technology education. The models reported in this study can be implemented to help teachers develop positive perceptions for meaningful conceptualisation of learning technology.

The study was important since it helped lay a foundation and knowledge from which further research, technology curriculum reforms and practices can be

established. In particular, the study resulted in a professional development model and a PATT model which can be scaled up in Malawi and the models can also be replicated in any setting. Through the models, teachers were supported to reflect on their experiences, beliefs and practices and influenced them to adopt positive views and technological pedagogical practices critical for broadening student technological literacy. The study also revealed that educational research underpinned by social-cultural frameworks of learning can help improve teachers' pedagogical knowledge and technological practices. The study provided teachers with a rare opportunity for further professional growth and development leading to improved teaching practices and knowledge about technology and technology education. Therefore, more research of this nature would be required to help develop capacity for reconstructing technology education in Malawi and other developing nations which may also plan to shift from industrial arts-based curriculum to a broad-based technology education.

8.0 References

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APPENDICES

Appendix 1: Narrative of Zagwa's lessons

Lesson One: Metalwork Design and Drawing

Zagwa's first lesson was about metalwork design and drawing with one student in Form 3. The lesson was a continuation of the previous weeks' work as the design process had already been introduced and the student's task was to generate design ideas. Zagwa said: "I discussed with him the whole design process. I also gave him a situation for design. I even gave him a brief for that particular problem." In this lesson, Zagwa aimed to impart skills for the student to be able to produce working drawings for his chosen design solution and he planned to use a pictorial sketch of an engineering component. As there were no lesson plans from the previous class work, Zagwa's schemes and records of work showed that previous lessons included a discussion on the examination paper for metalwork design and drawing. There were also lessons on properties of metal and development of a chosen idea which focussed on appearance, workability and suitability of materials.

The student was working on a project to design a portable coat hanger. Zagwa identified the design situation for the student and the design brief for the project: "Design a portable hanger for the headmaster's office" was also specified by Zagwa. As the design situation had already been set by the teacher, the student's tasks were simply to generate several ideas from which he would realise an appropriate solution to the problem. The context of the problem was however the teacher's and not the student's context. The student produced three design ideas and during the lesson, Zagwa discussed with him each of the ideas that he had produced and asked him to explain his investigations. Out of the three ideas, the student had already chosen his best idea but there were no selection criteria. Figure 1 shows sketches of the student's ideas which all seem to have been derived from an ordinary hanger with features, for example, the hook and the wings. The teacher also observed that the student developed one idea instead of producing different ideas from which the best solution would be chosen for

further development. The student was then asked to come up with more and different ideas for discussion in the next lesson.

After discussing the hanger project, the teacher focussed on the development of working drawings. According to Bertoline (Darling-Hammond, 2006; Ishak, 2008) working drawings are a complete set of standardised drawings with manufacturing and assembly specifications of a product. As the drawings are blueprints for manufacturing, it is required that they show graphics and text sufficiently complete and accurate to enable product manufacturing and assembly without error.

The lesson was taught using demonstration techniques. Zagwa used a pictorial sketch of an actual v-block. The v-block was sketched freehand on the chalkboard (see Figure 8). The parts of the v-block were disassembled and each part was drawn in detail. During the presentation, the student was also asked to draw the M8 bolt on the chalkboard in detail. The student had drawn it correctly but

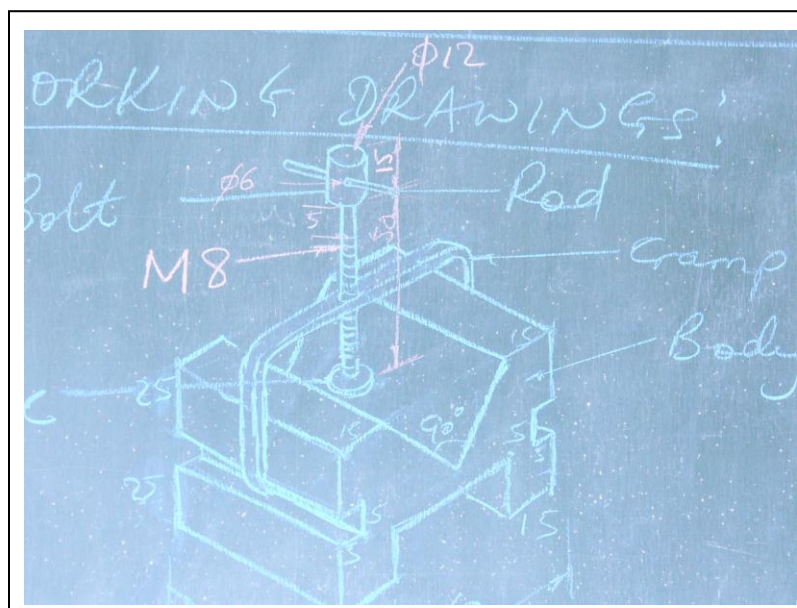


Figure 8: V-block in Zagwa's lesson

dimensioning of the threads was a problem as it required knowledge of conventions for the presentation of bolts. The teacher explained and finished the dimensioning of the drawing done by the student on the chalkboard. At the end of the lesson the student was asked to copy the views in detail as demonstrated.

Zagwa also asked the student to undertake the same process for making working drawings for the hanger project.

In a meeting after the lesson, Zagwa expressed satisfaction at having attained the learning outcomes although the student was unable to complete the drawing on the chalkboard which he attributed to the student's inability to apply drawing conventions. He also said that he should have prepared the model in advance other than sketching it on the chalkboard, as it took time to complete. In an interview, the student seemed satisfied with the work learnt and he was confident of producing working drawings for the hanger project. However, the student's work showed gaps in the design process and he needed support and coaching throughout the project. The gaps can also be seen from the graphic images of the student's design ideas in Figure 1.

Lesson Two: Construction of ellipses and parabolic figures

The second observation involved a Form Three class of 10 male students on manual technical drawing, covering the construction of foci, normal and tangents to parabolic figures such as ellipses and parabola. Zagwa's lesson took place in the drawing room. The room was fitted with wooden drawing benches and stools (see Figure 9). There were wooden drawing boards and also new portable plastic

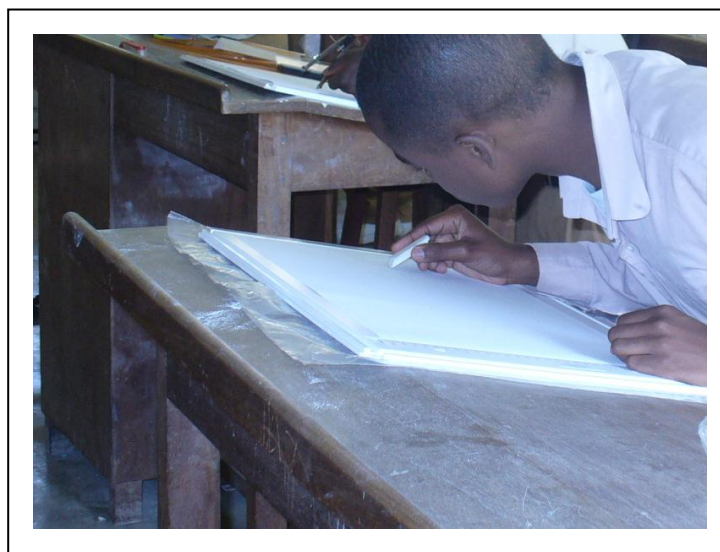


Figure 9: A pupil in the Drawing room

drawing boards, recently provided for all technical secondary schools by the Ministry of Education and Vocational Training. The students were each given a new drawing board and new sets of drawing tools such as setsquares and scale rules. The students were also provided with A3 drawing paper for their class exercises and homework. Plans for the technical drawing lesson were also seen in his schemes of work as he had no other notes. He planned to revise the construction of a parabola and an ellipse followed by a new topic on the construction of foci, normal and tangent to both figures. Zagwa relied on the schemes of work and examples from a technical drawing textbook. The construction problems were all written on the chalkboard. The teacher asked the students questions in order to find out about their existing knowledge and it was shown that they had knowledge of the construction processes of the objects under discussion.

The teacher demonstrated on the blackboard throughout the lesson and generated an ellipse and a parabola with the foci and tangent points. Students participated by way of answering questions to explain some stages in the construction of the ellipse and parabola. Although the students prepared their papers and boards for drawing practices, there was no time to practice as the teacher continued with the demonstration. Then the students were asked to copy the constructions that were drawn on the chalkboard. None of the students was able to finish copying during the lesson. The students were then asked to finish the constructions during their own time and submit the work on the following day.

There was no reflective discussion after the lesson as the teacher went away for a meeting soon after the class. However, his records of work showed some reflections as he recorded his evaluation of the lesson after marking the students work. Zagwa's lesson evaluation was as follows: "All the students were able to do the constructions. However smoothness of the curves was not well done by some students. They need to start using French curves." In a discussion with four of the students after the lesson, they were excited since basics of the content had been learnt in the junior classes but there was just no time to show their skills.

Appendix 2: Narrative of Papsya's lessons

Lesson 1: Technical drawing

Papsya's first class involved a technical drawing lesson with four Form 4 students. Papsya did not have any notes or written plans for the lesson except for his schemes of work and a model answer for an assembly drawing question from the test administered in the first term. The schemes of work showed that last term's lessons included both geometrical and orthographic drawing and the end-of-term-one test covered all these aspects. The lesson was therefore a revision of that test. The test had two sections; the first section covered geometrical constructions and the second comprised an orthographic question involving assembly drawing. Papsya revised section two only as none of the students completed the assembly drawing. The lesson was delivered through lecturing and demonstration methods with little student activity.

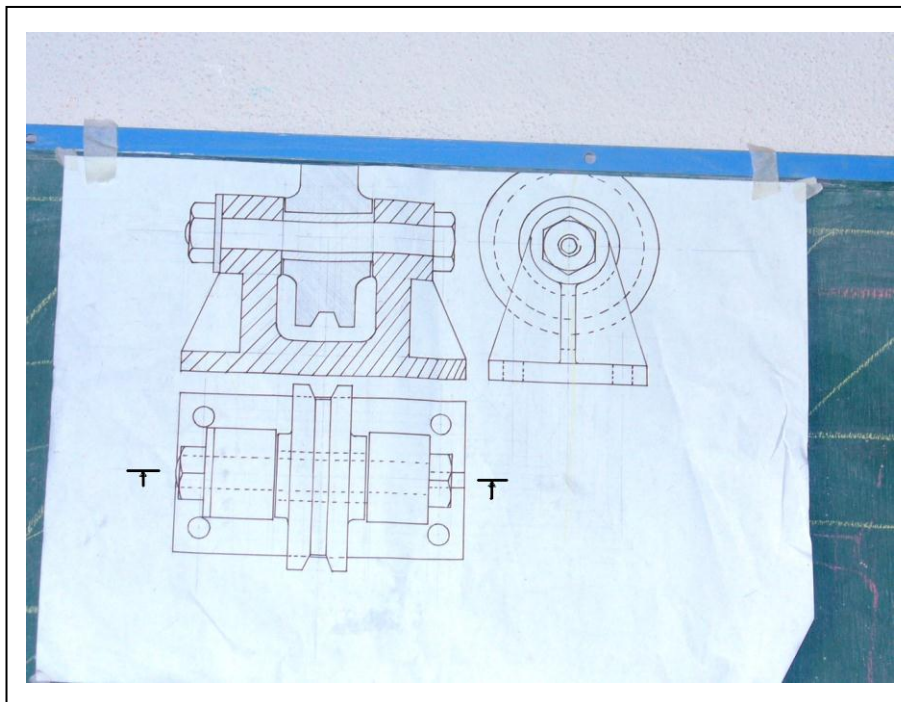


Figure 10: Papsya's teaching aid

The question about assembly drawing required students to assemble parts of a pulley with all details provided in the test paper. During the revision lesson, Papsya explained the weaknesses of the students in general and these included: inconsistencies in the use of symbols, direction of hatching lines of different parts

and sectioning planes and arrows. In order to address the students' difficulties in understanding this better, the teacher used a model answer pre-drawn on A3 paper and it was fixed on one side of the chalkboard (see Figure 10). The teacher then asked the students to redraw the pulley, fully assembled, and submit the finished work for checking but none managed to complete it during class time. In an interview after the drawing lesson, the teacher said that the students had difficulties applying drawing conventions. He acknowledged students' problems in completing the task and he attributed it either to time, level of difficulty or students' lack of understanding of the problem. In brief discussions with each student while in class, it was observed that the students had problems interpreting the details to decide where to fit each part. They also ran out of time to complete the tasks during lesson time. The students mentioned however that most of the processes and conventions were not unfamiliar to them as they had learnt them before, but imminent examinations made the students feel nervous.

Lesson 2: Woodwork Design

Papsya's second lesson was on woodwork design with three Form 3 students. The class took place in the wood workshop which contained ageing wooden benches and a pile of off-cuts of timber in one corner. Just in front of the benches, there was a pillar drilling machine and a power circular saw. Around the sides of the workshop, there were two wood lathes on one side and a planing machine on the other side. All the machines except one lathe were in usable condition and adequate for teaching and learning woodwork. The teacher also had no lesson plans or notes but in an interview before the lesson he indicated that he was going to teach the students the design process and would focus on identifying situations for design, developing a design brief and design ideas. The work planned was also verified in Papsya's woodwork schemes of work. The schemes also specified one reference book for design but there were no student copies.

The teacher introduced design to the students and lectured on the design process. While in class, he provided a scenario for the students in order to explain what design was. He said:

Suppose, you suddenly realise that tomatoes are being eaten from your store room. After a thorough check you find out that the store room has some rats. There are two ways of mitigating the problem. Either you poison the rats through the same tomatoes or you get yourself a rat trap. The traps in the shops are expensive. Therefore design a trap to get rid of all the rats from the house. (Papsya)

After the narration, he sketched three possible rat traps on the chalkboard and explained how each would operate to catch rats. He used the sketches to explain the entire design process. He asked the students to come up with design problems for discussion during the following week's lesson. The students were required to complete four of the design stages: problem identification, design brief, investigation and development of ideas or solutions.

In a brief group discussion with the students they narrated what they had learnt about the design processes. One student said that he had learnt that they should design with availability of construction materials in mind. Another student added that, for any design, there must be a purpose and each solution should be tested to evaluate its functionality and whether it meets the purpose. A third student emphasised the need for a cutting list to provide exact sizes and quantities of materials to reduce waste and cost of the final product.

Lesson 3: Woodwork design

The third lesson was observed in order to see the kind of situations the students developed after being introduced to the design process. Besides the researcher's interest in the students' ideas, the teacher's approach to the lesson was also important as it provided an indication as to how much support the teacher provides to students during the design stages. During the lesson, Papsya was reading each student's situation, design briefs and their ideas on investigations. After reading each student's work he suggested that the students should improve their investigations and gave them a general procedure to improve their designs. He suggested that they should ask themselves as many questions as possible with the questions focussing on joinery, materials and the manufacturing processes.

Papsya also advised the students to identify design problems within their environment. He told them that “Activities that you get yourself involved in at home or in school could be sources for a design situation”. He gave them an example as follows:

Think of the mops for cleaning the floors in your hostels or at home as a source of a design situation. After cleaning the mops are kept against the walls to dry and normally you would stick them there till the next time you want to mop. However, the mops keep the walls dirty, wet and the place becomes untidy. Think of a solution to this problem. (Papsya)

Without allowing time for the students to engage any further with the example Papsya continued reading the students’ design solutions and briefs. Although he asked for their observations at the end of each presentation, the students had difficulties critiquing their peers’ project due to their lack of deep understanding of the design process.

The situations showed the students’ abilities to identify design situations from their own experiences at school or at home. However, the students’ investigations just involved asking themselves questions and providing answers they thought would be important in making their designs. The activity did not include a market and environmental analysis to determine whether society needed such products or how the existence of similar products would affect their designs. The focus of their investigations were more on materials while other engineering factors such as ergonomics, environmental impact and production processes were not much considered. The teacher rushed them into further design stages before they were capable of identifying meaningful design situations. For instance, at the end of the lesson Papsya asked the students to identify yet more design situations for the next lessons. He said:

You keep these situations for now. Think of other situations. For next week, identify some more problems and situations. Write down the situations, design brief, investigation. Think of possible solutions to the problems and present them in isometric and then exploded views. (Papsya)

Pedagogical practices did not support the students learning of the design processes and practices as the students' situations, briefs and investigations showed a lot of gaps in their conceptualisation and understanding of the design process. For instance, one student identified spoiling of a lounge suite by siblings as a problem but his design brief included designing dining chairs. His brief addressed only one problem; about children's eating or feeding facilities around a lounge suite which may have required specially designed chairs for the kids.

Appendix 3: Narrative of Didi's lessons

Lesson 1: Revision

Didi's first lesson was on revision of the end-of-term-one test. During a meeting before the class, Didi explained the students' weak points in the test, lesson content, learning outcomes and also presentation techniques. He explained that students got low grades – the highest being 61% while the lowest mark was 16%. He attributed the performance to students' problems related to low drawing speed and inaccuracy as the students lacked appropriate drawing tools and also a lack of practice. He also attributed the students' lack of enthusiasm in learning drawing in particular and technical subjects in general as another important factor which greatly influenced their performance. Didi's schemes of work were not yet complete and he had no notes other than the test paper and the drawing textbook.

Didi revised only those items that were attempted by few students and these included external and internal tangency and also the construction of a circle touching two tangents. Didi began his lesson by writing one of the test items on the chalkboard. The students prepared their papers and drawing boards. Each student had a new drawing board and a set of drawing instruments provided by the Ministry of Education and Vocational Training. Before the donation, students were using wooden boards, try squares and set squares and others often used mathematics sets. The teacher demonstrated the constructions for the item. During the demonstration he involved the students by asking them to explain some of the basic construction procedures and others were asked to do the actual construction on the chalkboard. All the construction procedures were also written on the chalkboard for students' use at the end of the lesson. The teacher then modified the dimensions of the problem above and requested the students draw it as a class exercise. While the students were drawing, the teacher moved around to check each student's progress but noted the students poor line work due to the type of pencils (HB) and they were also erasing frequently, leading to dirt on their papers. He also noted their lack of proper drawing conventions. He discussed all these with the students and then allowed them to continue with the class exercise. As the students did not complete the construction, Didi instead asked the students to finish it during their own time and submit later for grading.

After the lesson, there were separate meetings with the teacher and the students to get their reflections on the lesson. Overall the teacher felt satisfied with the lesson since he covered all that he had planned to teach. He was also happy with the teaching method that he used but he added that he should have involved the students more to demonstrate the construction on the chalkboard.

In a reflective meeting four students viewed the lesson as positive and they rated it as a good lesson as they understood the content though they did not finish the class exercise because of time. The students were unable to identify any problems with the lesson and could not think of anything they would have wanted to see the teacher do differently for them to understand the lesson better.

Lesson 2: Loci of simple link mechanisms

Didi's second lesson was about loci of simple link mechanisms and he planned to teach the lesson by demonstration with the students drawing at the same time. Loci of simple link mechanisms is a topic in technical drawing and it involves construction of mechanisms by tracing the path of a point; for instance a connecting rod joining a piston and crankshaft or a rod sliding between two fixed straight lines. In this lesson Didi aimed to impart skills for students to be able to

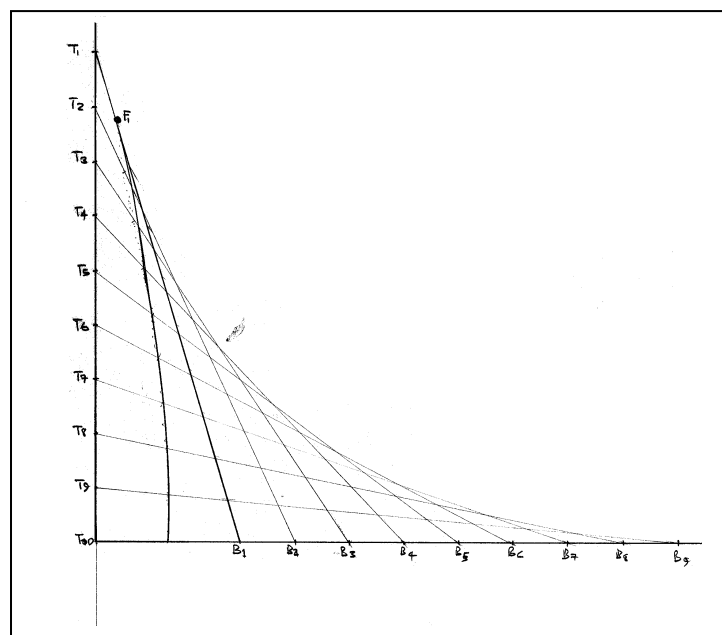


Figure 11: Locus of a point on a ladder in Didi's lesson

Didi asked the students to draw as he demonstrated on the chalkboard. He gave instructions for each step as he demonstrated what the students should draw. Students also completed each stage and did the same for all the stages until they had traced the path of the foot F. He showed them the model he had drawn for the students to check against their own drawing. The second part of the lesson was about the link mechanism. Didi reminded them of a children's game in the village where they move a bicycle wheel along using a string tied through one of the spoke holes. He also mentioned other examples of link mechanisms and these included the sewing machine and crankshaft-piston movement in car engines. However these examples were abstract and students' learning was not consolidated with hands-on experience of the operation of these mechanisms, including the bicycle wheel game. He gave them dimensions of a link mechanism and asked them to trace a point on the connecting rod between the piston and the crankshaft (see Figure 12). He went round to check students' progress but he noted the students were unable to divide a circle into 12 equal parts. He therefore asked one student to demonstrate on the chalkboard how to produce the divisions on a circle. The student used a compass but the teacher also showed them how to do the same task using $30^{\circ}/60^{\circ}$ set squares.

In a reflection meeting after the class, the teacher was excited at having achieved the learning outcomes as he covered all the planned work. He also indicated that he had used more practical examples than in previous lessons. The only problem was that students came late to class which he attributed to their lack of interest in technical subjects. However, he felt that if the lesson could include familiar examples, it could help attract them to study the subject more keenly. He also said that he only used students to demonstrate constructions on the chalkboards after noticing their weaknesses. Students seen to be doing correct constructions were asked to demonstrate to other students. Overall the teacher interacted with students in the second lesson more than in the first which may also have helped students to complete their class tasks.

From section B, Mdzulo also revised one question about a junction pipe made of a right cone and a square prism. The problem involved the generation of an intersection line between the cone and the prism and also the development of the cone. He used the same demonstration procedures by also involving students in the construction of parts of the intersection on the chalkboard. At the end of the lesson, Mdzulo asked the students to redo the other items in the test and to submit their completed work before the next lesson.

After the lesson there was a discussion with the students and they indicated that the lesson was fine as they understood their mistakes which they made in the test. However, construction clues and what was expected of them were unclear but after the lesson the students developed a better picture. The students also noted that the teacher allowed them to participate throughout the lesson. Their participation was in a form of answering questions and drawing parts of the constructions on the chalkboard.

Lesson 2: Sketching

In this lesson Mdzulo taught freehand sketching and used drawing conventions from a drawing textbook for students to sketch on their drawing papers. In his introduction, Mdzulo stated that freehand sketching constitutes Paper 2 of technical drawing examinations. In this paper, students make sketches depending on the objects given in the question. The lesson therefore focussed on drilling the students to prepare them for drawing examinations. The lesson began with Mdzulo asking the students about the meaning of sketching and one student defined it as drawing objects without use of any scale. Mdzulo then described the sketching processes and explained that the process could easily be done by freely dragging the hand holding a pencil across a paper where the desired drawing is to be sketched. Mdzulo demonstrated by twisting the hand with the arm as a focal point or centre point and asked the students to do the same and sketch few lines on their papers. Mdzulo then sketched engineering conventions on the chalkboard for students to copy.

The lesson content covered two separate concepts; sketching and conventions. There were discussions on how to implement established conventions in

presenting their drawings but students had no opportunity to develop capabilities to incorporate the theories. There were no meetings after the lesson as the students were supposed to attend other classes while the teacher went away for a social gathering in his neighbourhood. This lesson showed gaps in linking appropriate pedagogical approaches for learning drawing conventions and sketching.

Appendix 5: Narrative of Buli's lessons

Lesson 1: The construction of a number of circles in a given circle

Buli's first lesson aimed to impart skills to enable students draw different circles using given conditions and this lesson was about the construction of five circles in one big circle. His teaching strategy included demonstration and students were also to participate in physically constructing the drawings on the chalkboard. The students were provided with A3 drawing paper and masking tape for fixing the paper on the board but they had no pencil sharpeners and instead they used the floor, classroom walls and sandpaper. Buli had no notes and did not prepare any lesson plans. He relied on the schemes of work and a drawing textbook. Students did not have copies of the textbook for their own reading and practice.

Buli gave a recap of previous weeks' lessons but students could not explain the procedures for constructing external tangents. After the previous lesson, the students were given an exercise to complete during their own time but were unable to do it as there was no power during the night. While referring to a book, the teacher asked students to discuss the construction procedures in groups but the groups were not given tasks and guidelines. As a result, the discussions did not seem to enhance the students' understanding of previous work on tangents. The teacher then proceeded with the day's work involving the construction of five circles in a given circle. The first task was to divide the bigger circle into five equal parts and students had difficulty explaining how the divisions on a circle could be done. As a way of demonstrating he asked students, one after another, to do constructions on the chalkboard. These included marking divisions on the bigger circle, bisecting angles, drawing perpendiculars, drawing circles for each sector. Buli explained the practical significance of each of the constructions, such as fitting a number of drums into a given container but he did not tap into the students experiences for other examples in which such constructions could be applied. Towards the end the students were given two construction problems as a class exercise. From discussions with students during the exercise, it appeared that the students had some knowledge of the tasks required of them but they needed more practice and support. It was also observed that students were losing time as they were sharing some drawing tools such as erasers, protractors and appropriate

2/3H pencils although some were using HB pencils which affected the accuracy of their line work. Only two students completed the construction before time was up and one student's construction is shown in Figure 14.

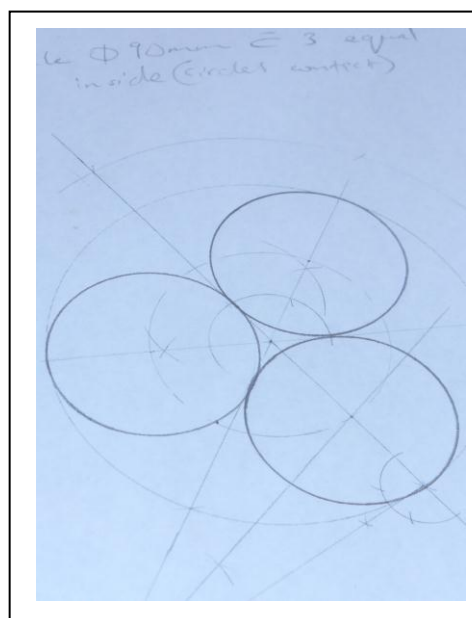


Figure 14: Student's completed work in Buli's class.

In an interview after the first lesson, Buli explained that the lesson had gone well despite a few of the students being unable to complete the constructions. He indicated having achieved the learning targets although some students were struggling to draw accurate lines. Accuracy affected their construction of circles within the big circle. Buli therefore indicated that he would encourage students to do more practice and to use appropriate drawing instruments. Buli also said that the teaching strategies he adopted (teacher demonstration and students doing constructions on the chalkboard) also assisted in the delivery of the lesson as it gave the students a chance to practice. His observations were also reflected in his evaluation remarks in the records of work.

Lesson 2: The construction of a number of circles in a given polygon

Buli's second lesson was on the construction of a number of circles within a given polygon. In a discussion before the lesson, Buli explained the learning outcomes, methodology and practical applications of the lesson. The lesson was aimed at

helping students to appreciate the applications of the constructions in industry. He planned to achieve the outcomes through what he called ‘group discovery’ where students were in groups of three to discuss and draw internal circles within a regular polygon. After the group work he planned to demonstrate the constructions.

Buli was worried however, that the syllabus did not stipulate any applications for teaching. He said: “The problem though is the syllabus as it does not specify the kind of applications. We just look at these things on our own. Our syllabus is an old one.” Buli said that the applications were necessary to help students’ learning and when he finds relevant things in the workshop, he exposes them to the application of the concepts learnt in the classroom. He also planned to give students a class exercise which was to be graded.

Buli introduced the lesson by also explaining the application of the knowledge to be learnt. He said:

In industry, instead of using circular things, sometimes they produce regular shaped containers to carry drums. In this lesson we therefore want to see how designers in industry best estimate the number of drums to fit into a regular shaped container... usually the designs are drawn to scale.

(Buli)

Buli checked the students’ prerequisite knowledge by asking them questions to explain the characteristics of regular polygons and construction procedures. He then divided the students into groups of three to discuss how to construct circles within a hexagon. He asked the students in their groups to discuss the construction procedures for the hexagon. Buli moved around checking each group’s progress and provided support where necessary. He also asked the students to discuss, in their groups, how to draw circles in the hexagon after constructing the triangles. The students discussed how to construct one circle in one of their chosen triangles. The procedure was replicated for the other triangles in the hexagon. It seemed to be difficult for the students to share group roles as everyone wanted to draw. In some groups the same person continued drawing with the rest shouting out their views about the constructions. After the group work, the teacher sketched

another problem on the chalkboard involving construction of external circles and it was demonstrated with students participating by completing the parts on the

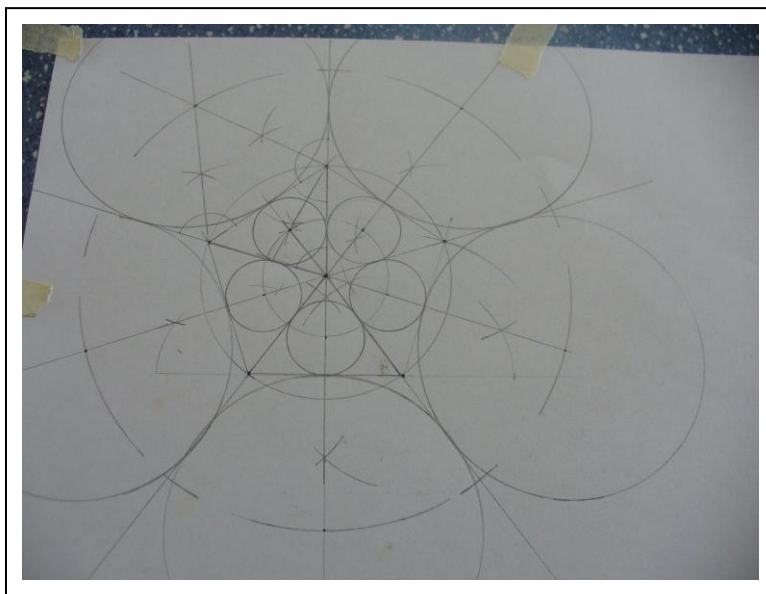


Figure 15: Ascribed and inscribed circles drawn by Buli's student

chalkboard. The teacher went round to mark all the group work. At the end, the students were given a class exercise to be completed by individual students but the problem did not require much thinking as the students just redrew the same problems as in the demonstration since Buli just changed the number and lengths of the sides. Besides, as there was no time, only one student managed to complete the exercise and the student's drawing (see Figure 15).

After the lesson the teacher expressed satisfaction with the techniques adopted for the lesson. He also indicated that he wanted to undertake a final analysis of their learning after marking their papers. His general feeling was that the students had problems with their line work, accuracy and time management. Buli suggested more practice and assignments for the students to improve in their drawing. His evaluation of the lessons as in his schemes and records of work also showed similar sentiments as reflected during the discussion.

Appendix 6: Narrative of Chiipira's lessons

Lesson 1: Revision of drawing test

Chiipira's first lesson involved revision of the end-of-term one test and he revised only geometrical questions as most students failed these during the test. Only three out of eight students attended the lesson, as most students had not yet enrolled. He had no notes or lesson plans but he relied on the question paper and the drawing textbook. In a discussion before the class he outlined his learning outcomes, teaching methods and students' activities. The lesson was all about imparting drawing skills through demonstration followed by a class exercise. The classroom events are described below.

After cleaning the drawing room, the teacher distributed new drawing boards which had just been supplied by the Ministry of Education and Vocational Training. The revised items included construction of an octagon within a square and an Archimedean spiral. During demonstration the teacher asked the students one after another to explain construction procedures and also to draw specific areas of the items on the chalkboard. Chiipira asked each student to make constructions on the chalkboard and to explain to the whole class all their construction procedures. One student attempted the construction of the Archimedean spiral but was unable to complete the construction. The teacher explained and demonstrated the construction of the remaining parts of the Archimedean spiral and then asked all the students to complete the drawing. For the final part of the lesson, the teacher demonstrated the tracing of the locus and asked the students to complete it. He asked them to redo all the items in the test and submit them later. As this was revision, the lesson reflected some knowledge gaps in the students as the constructions were basic for Form Four students.

It was also noted that the new drawing boards distributed to each student were not used as the students were also using the chalkboard with the teacher. Chiipira explained that he had planned to involve the students in the demonstration and, at the same time, he wanted them to practise. He decided to demonstrate as the students were unable to complete the constructions. He also just wanted to involve the students which meant them drawing on the chalkboard. Through the

reflections, Chiipira was able to see the gaps in the teaching methods and was willing to adopt new techniques. He indicated that in the forthcoming lessons he was going to involve the students more although he was not sure how else he would involve them other than by answering questions or working on the chalkboard.

Lesson 2: Development of cylinders and pyramids

Chiipira's second lesson was about development of cylinders and pyramids with a class of seven students. Chiipira relied on the drawing textbook and the schemes of work. Development is a pattern-making process where thin sheet materials such as cans, pipes, elbows, boxes, ducting, hoppers and many others are drawn to produce templates. As the lesson was a continuation from the previous term, students were expected to have some knowledge and understanding of the principles of development.

The lesson began with Chiipira drawing the front view or main view of a truncated cylinder on the chalkboard while students were preparing their drawing boards and paper. Two students were asked to complete a plan view and an end view on the chalkboard while the other students began drawing the views on their boards. The students had the correct drawings on the chalkboard and the teacher demonstrated the other stages of the development process, pausing at the end of each stage to give students time to complete their drawings. It was noted that the demonstration covered areas where students had prior knowledge and skills and they could have easily drawn the elevations on their papers.

While the students were completing their drawings, I moved around the class and talked to two students separately and they explained the process of developing the cylinder as they understood it. As the teacher finished the demonstration with a complete outline of the development of the cylinder, all the students completed their drawings but with poor line work.

Chiipira also introduced another construction about the development of a truncated hexagonal pyramid and students were asked to draw while he demonstrated. During pauses the teacher moved around the class to check on each student's progress. One student asked the teacher how to obtain the true length of a side of the pyramid.

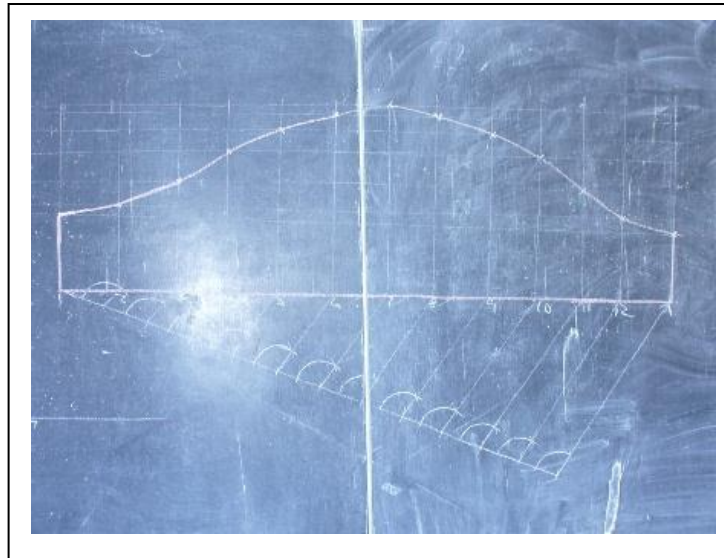


Figure 16: Demonstration of development in Chiipira's lessons

The teacher explained the process and asked them to proceed with the rest of the constructions. I also asked four of the students and they all seemed to be doing the constructions correctly. The completed drawing on the chalkboard is shown in Figure 16. After the demonstration, the students completed their drawings and Chiipira gave the students an exercise to be completed during their own time. The exercise was on the development of a jug and the students were given full dimensions of the front view of the jug. Chiipira explained the practical implications of the exercise through an example of a situation based on a tinsmith project. He said:

A tinsmith has a project to manufacture water jugs to be used in a refugee camp. The tinsmith wants you to design a template to enable mass production of the jugs. The development of the jug will therefore be a template needed for the tinsmith's project. (Chiipira)

After the lesson, there was a discussion with the teacher and he was excited at having attained the learning outcomes. Upon reflection, Chiipira became sceptical about the effectiveness of students' involvement on the chalkboard towards the learning of drawing skills. He indicated though that for revision, it helps to keep them attentive but for a new lesson the method would not be as effective. However, he hinted that at times it serves as a motivation for the other students to learn from their peers. Chiipira viewed his lesson as a success as he had attained the learning outcomes and planned to give students more activities in the next lesson.

Chiipira evaluated his lesson as shown in his schemes and records of work. A meeting with the students at the end of the lesson showed that they were enthusiastic about the lesson and were able to explain what they had learnt. Students expressed their excitement at having been able to complete all the tasks in class and they were certain to get the exercise right.

Appendix 7: Workshop programme


WEEK SEVEN (12-16 May, 2008)

SESSION ONE (12 May 2008)

- Introduction and housekeeping issues.
- Participants' workshop expectations.
- Discussion of teachers' existing views about technology and technology education (to be audio taped).

SESSION TWO (13 May 2008)

Teachers will explore the area of technology education by considering what is meant by technology in general. Readings will be distributed to the teachers in advance and the discussion will be in their school groups. Each school will randomly be assigned two modules; one from each of the sections. Each group will present their understanding of the readings and all the participants will reflect on each group's presentation. A video on Know-how 2 (2002) produced in New Zealand will help teachers to conceptualise technology and how technology education can be implemented in the classroom.

 *What is technology?*

Teachers will discuss their understanding of the meaning of technology. The following readings will help teachers to explore the meaning of technology and examine the relationship between science and technology. Each school will be assigned one article to read and prepare for a presentation of an argument based on their reading.

- Harrison, M. (1994). Science and technology: Partnership or divorce. In F. Banks (Ed.), *Teaching Technology* (pp. 238-245). London: Routledge.
- Layton, D. (1993). Understanding technology-the seamless web. In D. Layton (Ed.), *Technology's challenge to science education* (pp. 23-30). Buckingham: Open University Press.

- Naughton, J. (1994). What is technology? In F. Banks (Ed.), *Teaching Technology* (pp. 7-12). London: Routledge.

The questions to help guide reading of the papers are:

- What are the key components of technology?
- How do these key components influence your understandings of technology?
- What are the implications of the components of technology on the implementation of technology education?

 Know-how 2 video (Ministry of Education, 1997) – New Zealand cases

- Enhance the teachers' understanding on the nature of technological practice (Cases: Circa: Building The Master Builder, Fisher and Paykel: Smart Drive, What noise annoys? Main Street, and Mighty Milk)

WEEK EIGHT (19-23 May 2008)

SESSION THREE (19 May 2008)

The teachers will explore the concepts related to theorising of knowledge and implications for learning in technology.

- Learning in technology:

In this section teachers will explore learning in technology and will also focus on the interaction of technological knowledge, processes and skills. Problem solving through project-based learning will be discussed in relation to its implications to learning in technology. Focus question: How do learning theories need to be adapted to take account of learning in technology?

- Glaser, R. (1993). Education and thinking: The role of knowledge. In R. McCormick, P. Murphy & M. Harrison (Eds.), *Teaching and Learning Technology* (pp. 91-111). Wokingham: Addison-Wesley Publishing Company in association with The Open University.

- McCormick, R. (2004). Issues of learning and knowledge in technology education. *International Journal of Technology and Design Education*, 14(1), 21-44.
- Mioduser, D., & Betzer, N. (2008). The contribution of project-based-learning to high-achievers' acquisition of technological knowledge and skills. *International Journal of Technology and Design Education*, 18(1), 59-77.
- Social views of learning?

This section explores social views of learning such as situated cognition, cognitive apprenticeship and their implications for classroom practices. Students learning by social interaction and collaboration that is situated in specific cultural and authentic contexts will be discussed. Focus question: How appropriate is the idea of situated cognition to technology education?

- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.
- Hennessy, S. (1993). Situated cognition and cognitive apprenticeship: Implications for classroom learning. *Studies in Science Education*, 22, 1-41.
- Lave, J. (1991). Situating learning in communities of practice. In L. Resnick, J. Levine & S. Teasley (Eds.), *Perspectives on Socially Shared Cognition* (pp. 63-82). Washington: American Psychological Association.

SESSION FOUR (20 May 2008)

- What are the methods for teaching technology?
 - Jones, A., & Carr, M. (1993). A framework for technology education. In *SAMEpapers 1993* (pp. 1-48). Hamilton, New Zealand: Centre for Science and Mathematics Education Research, University of Waikato.
 - McCormick, R. (1992). The evolution of current practice in technology education. In R. McCormick, P. Murphy & M. Harrison (Eds.), *Teaching and Learning Technology* (pp. 3-14). Milton Keynes: Open University Press.

- Williams, P. J. (2000). Design: The only methodology of technology. *Journal of Technology Education*, 11(2), 48-60.

NINTH WEEK (26-30 May 2008)

SESSION FIVE (26 May, 2008)

This session will involve teachers in reflecting on Know-how 2 video (Ministry of Education, 1997), a visit to a technological site and school level instructional design. Each school group will develop teaching plans based on work covered in sessions three and four, the visit in session five, and existing curriculum. These will be tried in the schools.

- Visit to a technological site (shopping mall, industry, urban high density residential area or rural village)
- Know-how 2 video (Ministry of Education, 1997) – New Zealand cases:
 - Teachers' understanding of issues on classroom implementation of technology education. (School: Hora Hora School, Mangere Central Primary School, Taukau College).

SESSION SIX (27 May 2008)

- School presentations of technology models (to be audio/video taped)
- Discussion of teachers' current views about technology, technology education and science and technology (to be audio taped).
- Recap
- Closing Remarks

Further Readings

- Adams, J. (1993). A brief history of technology: The underpinnings. In J. Adams (Ed.), *Flying buttresses, entropy, and o-rings: The world of the engineer* (pp. 5-30). Cambridge, MA: Harvard University Press.
- Barak, M., & Maymon, T. (1998). Aspects of teamwork observed in a technological task in junior high schools. *Journal of Technology Education*, 9(2), 4-18.

- de Vries, M. J., & Tamir, A. (1997). Shaping concepts of technology: What concepts and how to shape them. *International Journal of Technology and Design Education*, 7(1), 3-10
- Hennessy, S., & McCormick, R. (1994). The general problem solving process in technology education: Myth or reality. In F. Banks (Ed.), *Teaching Technology* (pp. 94-108). London: Routledge.
- Jones, A. (1997). Recent research in learning technological concepts and processes. *International Journal of Technology and Design Education*, 7(1), 83-96.
- McGrath, A. (2002). *The model of situated cognition: Lessons for technology education*. Paper presented at the Learning in technology education: Challenges for the 21st century, Proceedings of the 2nd Biennial International Conference on Technology Education Research held at the Parkroyal Gold Coast, Australia, 5 – 7 December 2002. Retrieved March 3, 2008 from <http://teched.vt.edu/ctte/ImagesPDFs/TERC2002vol2.pdf>
- Stevenson, J. (2004). Developing Technological Knowledge. *International Journal of Technology & Design Education*, 14(1), 5-19.

Appendix 8: Teachers' Interview Guide

The interviews with teachers will be unstructured (Ministry of Education, 1997). As the discussion will be flexible and more exploratory, rapport will be established before the interviews. The interviews will be audio taped, with permission from the teacher. With the teachers consent, copies of planning notes and teaching materials will be made and originals will be returned to the teachers. Copies or pictures of student's work or artefacts from this lesson or previous lessons where necessary will also be gathered for analysis. Permission to take pictures during the lesson will also be sought from the teachers and students. The pictures may include any group activities, students' work or teachers' illustrations written on the chalkboard or any visual aids.

BEFORE Professional Development

Attributes:

1. What is your background [education background, home/parental background, length of service, interest in technical subjects/factors that shaped your career as a technical teacher]

Teachers' views on technical education, technology education and Science and Technology.

2. What is technical education?
3. Why should students learn technical subjects?
4. How do you view the teaching of technical subjects in schools? Any changes that you would want to suggest?
5. Are there any problems that affect the teaching of technical subjects and what remedies do you suggest?
6. What does technology mean to you?
7. What does technology education mean to you?
8. What is the difference between technology education and technical education?
9. What is the difference between Science and Technology?

10. What are your views about the teaching of Science and Technology alongside Technical subjects?
11. What do you think is an effective approach of teaching technology in schools?

Lesson planning

12. What will you teach today?
13. What do you intend to achieve by teaching this topic?
14. What strategies are you going to use for teaching this topic and why?
15. Would you please take me through your lesson briefly.

Reflection meeting after classroom observation

16. Did you achieve your set targets? If not, why and what are the remedies?
17. Do you think you need any improvement in your teaching methods and how could such improvements be done?
18. Which areas of the subject matter do you need improvement and what kind of support would you suggest?

AFTER Professional Development

Lesson planning interview

19. What will you teach today?
20. What do you intend to achieve by teaching this topic?
21. What strategies are you going to use for teaching this topic and why?
22. Would you please take me through your lesson briefly?
23. Are your strategies any different from the previous teaching strategies before the PD and what are the changes?

Reflection meeting after classroom observation

24. Did you achieve the target of your lesson? If not, why and what are the remedies?
25. If you compare previous and current classroom practices, is there any change and what do you think has changed?

26. In your opinion, do you think technology education can be established as a learning area? Explain how it could be done and what will be the benefits?

The interviews will be unstructured but all the above questions will have to be discussed. All discussions will be audio taped (consent will be sought in each case). A Contact Summary sheet will be completed at the end of each interview to reflect on the discussion and plan for the next interview.

Appendix 9: Pupils Attitude Towards Technology (PATT) Questionnaire

PART A - ATTRIBUTES

The questions in this section are about yourself and your home background. Follow instructions for each question else write your responses in the spaces provided.

1. What is your sex? (*Tick ✓ in the appropriate box*).

1	Male	<input type="checkbox"/>
2	Female	<input type="checkbox"/>

2. How old are you? _____

3. Where did you grow up?

1	Town	<input type="checkbox"/>
2	Village	<input type="checkbox"/>

4. What is your fathers' occupation? _____

5. What is your mothers' occupation? _____

6. What is your most admirable profession? _____

7. Do you have brothers in the technological profession? (*You can tick ✓ if appropriate*).

1	Yes	<input type="checkbox"/>
2	No	<input type="checkbox"/>

8. Do you have brothers studying towards a technological profession? (*You can tick \surd if appropriate*).

1	Yes	<input type="checkbox"/>
2	No	<input type="checkbox"/>

9. Do you have sisters in the technological profession? (*You can tick \surd if appropriate*).

1	Yes	<input type="checkbox"/>
2	No	<input type="checkbox"/>

10. Do you have sisters studying towards technological profession? (*You can tick \surd if appropriate*).

1	Yes	<input type="checkbox"/>
2	No	<input type="checkbox"/>

11. Is there a technical workshop in your home? (*Tick \surd one box*)

1	Yes	<input type="checkbox"/>
2	No	<input type="checkbox"/>

12. Is there a computer in your home? (*Tick \surd one box*)

1	Yes	<input type="checkbox"/>
2	No	<input type="checkbox"/>

13. What kind of toys were you playing with when you were young? (*List as many as you can remember*)

14. What is your fathers' education background? (*Tick \surd the highest level attained*)

1	No Education	<input type="checkbox"/>	4	College	<input type="checkbox"/>
2	Primary School	<input type="checkbox"/>	5	University	<input type="checkbox"/>
3	Secondary School	<input type="checkbox"/>			<input type="checkbox"/>

15. What is your mothers' education background? (*Tick \surd the highest level attained*)

1	No Education	<input type="checkbox"/>	4	College	<input type="checkbox"/>
2	Primary School	<input type="checkbox"/>	5	University	<input type="checkbox"/>
3	Secondary School	<input type="checkbox"/>			<input type="checkbox"/>

14. Which of the following subjects are you taking? (*Tick \surd in the box for each subject you are taking*).

1	Mathematics	<input type="checkbox"/>	8	Social Studies	<input type="checkbox"/>
2	English	<input type="checkbox"/>	9	Home Economics	<input type="checkbox"/>
3	Technical Drawing	<input type="checkbox"/>	10	Agriculture	<input type="checkbox"/>
4	Metalwork	<input type="checkbox"/>	11	Geography	<input type="checkbox"/>
5	Woodwork	<input type="checkbox"/>	12	Biology	<input type="checkbox"/>
6	Physical Science	<input type="checkbox"/>	13	Others (specify)	<input type="checkbox"/>
7	Science and Technology	<input type="checkbox"/>			<input type="checkbox"/>

PART B: ATTITUDE QUESTIONNAIRE

In this part of the questionnaire you are asked how you feel about technology. Please **CIRCLE**: *SA, A, U, D, or SD* if you *strongly agree, agree, disagree or strongly disagree* with each of the statements. *U* is for *Undecided* if you do not fully agree nor disagree.

s/n	Statement	Strongly agree	Agree	undecided	Disagree	Strongly Disagree
1	When something new is discovered, I want to know more about it immediately.	SA	A	U	D	SD
2	Technology is as difficult for girls as it is for boys.	SA	A	U	D	SD
3	Technology is good for the future of this country.	SA	A	U	D	SD
4	To understand something technological you have to take a difficult training course.	SA	A	U	D	SD
5	At school you hear a lot about technology.	SA	A	U	D	SD
6	I will probably choose a job in technology.	SA	A	U	D	SD
7	I would like to know more about computers.	SA	A	U	D	SD
8	A girl can do well in a technical job.	SA	A	U	D	SD
9	Technology makes most things work better.	SA	A	U	D	SD
10	You have to be very bright to study technology.	SA	A	U	D	SD
11	I would not like to learn more about technology at school.	SA	A	U	D	SD
12	I like to read technological magazines.	SA	A	U	D	SD
13	A girl can also become a car mechanic.	SA	A	U	D	SD
14	Technology is very important in life.	SA	A	U	D	SD
15	Technology is only for bright people.	SA	A	U	D	SD
16	Technology lessons are important.	SA	A	U	D	SD
17	I will not consider a job in technology.	SA	A	U	D	SD
18	There should be TV- and radio programmes about technology.	SA	A	U	D	SD
19	Boys are able to do practical things better than girls.	SA	A	U	D	SD

s/n	Statement	Strongly agree	Agree	undecided	Disagree	Strongly Disagree
20	Everyone needs technology.	SA	A	U	D	SD
21	It is not difficult to work with a computer.	SA	A	U	D	SD
22	I would rather not have technology lessons at school.	SA	A	U	D	SD
23	I do not understand why anyone would want a job in technology.	SA	A	U	D	SD
24	If there was a technology club, I would certainly join it.	SA	A	U	D	SD
25	Girls can operate a computer better than boys.	SA	A	U	D	SD
26	Technology has brought more good things than bad.	SA	A	U	D	SD
27	You have to be physically strong for most technical jobs.	SA	A	U	D	SD
28	Technology at home is not something that schools should teach about.	SA	A	U	D	SD
29	I would enjoy a job in technology.	SA	A	U	D	SD
30	Visiting a factory is boring.	SA	A	U	D	SD
31	Boys know more about technology than girls.	SA	A	U	D	SD
32	The world would be a better place without technology.	SA	A	U	D	SD
33	To study technology you have got to be talented.	SA	A	U	D	SD
34	I should be able to take technology as a school subject.	SA	A	U	D	SD
35	I would like a career in technology.	SA	A	U	D	SD
36	I am not interested in technology.	SA	A	U	D	SD
37	Boys are more capable of doing technological jobs than girls.	SA	A	U	D	SD
38	Using technology makes a country less prosperous.	SA	A	U	D	SD
39	You can study technology only when you are good at both mathematics and science.	SA	A	U	D	SD
40	There should not be more education about technology.	SA	A	U	D	SD

s/n	Statement	Strongly agree	Agree	undecided	Disagree	Strongly Disagree
41	Working in technology would be boring.	SA	A	U	D	SD
42	I enjoy repairing things at home.	SA	A	U	D	SD
43	More girls should work in technology.	SA	A	U	D	SD
44	Technology causes large unemployment.	SA	A	U	D	SD
45	Technology does not need knowledge of mathematics.	SA	A	U	D	SD
46	Technology should be a core subject.	SA	A	U	D	SD
47	Most jobs in technology are boring.	SA	A	U	D	SD
48	Working with machines is boring.	SA	A	U	D	SD
49	Girls prefer not to take technological training.	SA	A	U	D	SD
50	Because technology causes pollution we should make less use of it.	SA	A	U	D	SD
51	Everybody can study technology.	SA	A	U	D	SD
52	Technology lessons help to train you for a good job.	SA	A	U	D	SD
53	Working in technology would be interesting.	SA	A	U	D	SD
54	A technological hobby is boring.	SA	A	U	D	SD
55	Girls think technology is interesting.	SA	A	U	D	SD
56	Technology is the subject of the future.	SA	A	U	D	SD
57	Everybody can have a technological job.	SA	A	U	D	SD
58	Not everyone needs technology lessons at schools.	SA	A	U	D	SD
59	A technological job enhances prospects for a better future.	SA	A	U	D	SD
60	Boys prefer not to take training in technology.	SA	A	U	D	SD

PART C: CONCEPT QUESTIONNAIRE

In this part you are asked what you understand by the term “technology”. The questions are set out in a similar way to those in Part B, although the options for responses are slightly different. Please **CIRCLE A or D** about each statement to show whether you **agree** or **disagree** with the statement and **U** if you are **undecided** or not sure about the statement.

s/n	Statement	Agree	Don't Know	Disagree
1	Technology is all about machines.	A	DK	D
2	There is a relationship between technology and science.	A	DK	D
3	In technology you can seldom use your imagination.	A	DK	D
4	Technology has little to do with our energy problems.	A	DK	D
5	When I think of technology, I mostly think of equipment	A	DK	D
6	Technology and science are the same.	A	DK	D
7	Technology is not very old.	A	DK	D
8	In technology you can invent new things.	A	DK	D
9	Working with information is an important part of technology.	A	DK	D
10	Technology is as old as humans.	A	DK	D
11	Elements of science are rarely used in technology.	A	DK	D
12	You need not be technological in order to invent a piece of equipment.	A	DK	D
13	Technology has a large influence on people.	A	DK	D
14	Technology is often used in science.	A	DK	D

s/n	Statement	Agree	Don't know	Disagree
15	Technology is not part of daily life.	A	DK	D
16	Working with your hands is also part of technology.	A	DK	D
17	Technology affects everyday life.	A	DK	D
18	In technology there is little opportunity to make things.	A	DK	D
19	Science and technology have nothing in common.	A	DK	D
20	The government can have influence on technology.	A	DK	D
21	The transformation of energy is also part of technology.	A	DK	D
22	In technology, you use tools.	A	DK	D
23	Technology is all about new products.	A	DK	D
24	Technology is all about computers.	A	DK	D
25	Only technicians are in-charge of technology.	A	DK	D
26	Technology has always to do with production.	A	DK	D
27	In technology there are fewer opportunities to do things with your hands.	A	DK	D
28	Technology is meant to make our life more comfortable.	A	DK	D
29	In technology you learn more about computers.	A	DK	D
30	Working with materials is an important part of technology.	A	DK	D
31	There is no relationship between science and technology.	A	DK	D

*The end.
Thank you.*

Appendix 10: Authorisation Letters

1. Authorisation from the Ministry of Education and Vocational Training

Telegrams: MINED, Lilongwe
 Telephone: (265) 01 789 422/ 01 789404
 Telex: 44636
 Facsimile: (265) 01 788 064



MINISTRY OF
 EDUCATION AND
 VOCATIONAL TRAINING
 PRIVATE BAG 328
 CAPITAL CITY
 LILONGWE 3

Ref No. DP2/134/10

17th January 2007

CSTER
 School of Education
 University of Waikato
 P/Bag 3105
 Hamilton 3240
 New Zealand.

Dear Sir,

REQUEST FOR EDUCATION DATA FOR ACADEMIC PURPOSES (PhD STUDY)

Reference to your letter dated 27th December, 2006 in which you asked for permission to collect education data and the curriculum statements that shows what is offered in Primary, Secondary and Technical Schools and the Ministry circulars, publications, or gazetted information from this office.

You may wish to be informed that your request has been approved therefore, you may go ahead to collect the sought for data and statements.

Wishing you all the best during your project and hope that the study will help in the development of Malawi.

Yours Faithfully,

Dr. A. F. Kamlongera

For: SECRETARY FOR EDUCATION AND VOCATIONAL TRAINING

2. *Authorisation from Kabula Secondary School*

Appendix 1b: Invitation for Schools


Centre for Science and Technology
Education Research,
School of Education,
University of Waikato,
P/Bag 3105,
Hamilton, 3240, New Zealand.

27th November, 2007.

The Headmaster/Headmistress,

Blantyre Sec. School
P/Bag 10
Blantyre

*Authorised to conduct
his research*
J. Kabula



Dear Sir/Madam,

**AN INVESTIGATION OF THE PERCEPTIONS OF STUDENTS AND
TEACHERS IN MALAWI TOWARDS TECHNOLOGY: A FRAMEWORK
FOR TECHNOLOGY EDUCATION.**

I am writing to ask for your permission for the inclusion of your school in a sample of schools to be involved in a study titled "An Investigation of the perceptions of students and teachers in Malawi towards technology: a framework for technology education." The study will explore the students' perceptions towards technology and their likely influence to learning in technology education. The study will also explore the teachers understanding of technology and technology education. Their teaching practices will also be evaluated. It is hoped that the research will lead into the restructuring of technical education curriculum in schools to focus on broader views of learning in technology for the enhancement of the learners' technological literacy.

The study will engage two (2) teachers from each school in in-depth interviews and classroom observations. There will be focus group discussions with 4 form 3 students

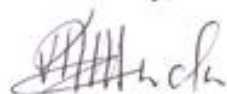
(2 female and 2 male) from each school. I will also analyse documents such as students work (assignments, projects and artefacts), teachers' lesson plans, schemes and all teaching and learning materials. Teachers will also be involved in a professional development to enhance their technological pedagogical content knowledge (PCK). Subsequent to the intervention, teachers will be involved in a series of co-teaching sessions, classroom observations and reflective meetings and follow-up interviews. The study will be conducted for a period of 2 years as it will involve implementation, monitoring and evaluation of an intervention.

The data so collected shall be used to write a research report for my thesis leading to the award of a PhD in Technology Education from the University of Waikato, New Zealand. Your authorization is a requirement of the University of Waikato Human Research Ethics Regulations 2000 and the ethical guidelines of the New Zealand Association for Research in Education (NZARE).

I assure you that the schools', students' and teachers' data will be kept confidential, pseudonyms will be given to provide anonymity, and data will be securely stored and used only for the purposes of the thesis and any academic papers and presentations that might arise from it. The students' academic progress and teachers' professional practice will not be compromised by their taking part in the study. The research participants will be free to withdraw at any time and are not compelled to participate.

Your response at the earliest convenience would be appreciated. I will call to make an appointment to collect your reply.

Yours sincerely,



Vanwyk K.M. Chikasanda

CC: Dr Judy Moreland - Supervisor
Principal – The Malawi Polytechnic

3. *Authorisation from Mudi Secondary School*

Appendix 1b: Invitation for Schools

Centre for Science and Technology
Education Research,
School of Education,
University of Waikato,
P/Bag 3105,
Hamilton 3240, New Zealand.

27th November, 2007.

The Headmaster/Headmistress,
Chichiri Sec. School
Blantyre

Permission is granted to
Mr Chikasande to conduct
research at his school as
requested in his letter.
Good Luck.

Dear Sir/Madam,

**AN INVESTIGATION OF THE PERCEPTIONS OF STUDENTS AND
TEACHERS IN MALAWI TOWARDS TECHNOLOGY: A FRAMEWORK
FOR TECHNOLOGY EDUCATION.**



I am writing to ask for your permission for the inclusion of your school in a sample of schools to be involved in a study titled "An Investigation of the perceptions of students and teachers in Malawi towards technology: a framework for technology education." The study will explore the students' perceptions towards technology and their likely influence to learning in technology education. The study will also explore the teachers understanding of technology and technology education. Their teaching practices will also be evaluated. It is hoped that the research will lead into the restructuring of technical education curriculum in schools, to focus on broader views of learning in technology for the enhancement of the learners' technological literacy.

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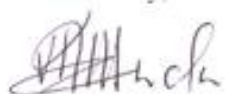
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Your response at the earliest convenience would be appreciated. I will call to make an appointment to collect your reply.

Yours sincerely,



Vanwyk K.M. Chikasanda

CC: Dr Judy Moreland - Supervisor
Principal – The Malawi Polytechnic

4. *Authorisation from Shire Secondary School*

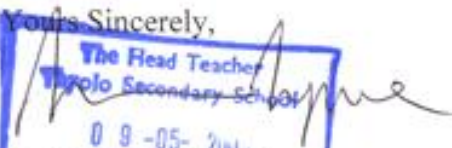
FROM : The Headmaster
Thyolo Secondary School, P.O. Box 34, Thyolo.

TO : Mr. Chikasanda.
The Polytechnic, Private Bag 303, Chichiri.

DATE : 9th May, 2008

SUBJECT: Conducting Research at Thyolo Secondary School.

In response to your letter addressed to my office whereby you were asking for a permission to carry out research on your project, I write to inform you that the permission has been granted on condition that your research is not going to affect the process of teaching and learning at this institution.

Yours Sincerely,

The Head Teacher
Thyolo Secondary School
09-05-2008
Y. MAKINA GAMA.
P.O. Box 34
Thyolo