TEACHERS PERCEPTION AND CONTENT .ANALYSIS OF THE NEW TECHNICAL COLLEGE MATHEMATICS CURRICULUM

BY

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AUGUST, 1988

DEDICATION

This study is dedicated to all the members of the Kyuleve family and my God.

DECLARATION

I hereby declare that this study has been conducted by me. Its topic has not been presented in any previous application for a higher degree in any University. All quotations are indicated by quotation marks and sources of information are dully acknowledged by means of references.



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August, 1988.

CERTIFICATION

This thesis entitled "TEACHERS' PERCEPTION AND CONTENT ANALYSIS OF THE NEW TECHNICAL COLLEGE MATHEMATICS CURRICULUM" by KYELEVE, JOHN IORHEMEN - meets the regulations governing the award of the degree of Master of Education (Mathematics Education) of AHMADU BELLO UNIVERSITY, and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

This study had two major related purposes. The first was to assess the teachers[1] perception of the new Technioal College Mathematics Curriculum (TCMC) in terms of six curricular issues. The effects of the technical teachers qualification and the type of technical programme on the teachers' perception were also examined. The second purpose was to undertake a detailed content analysis of the new TCMC in relationship with the curricula of the three major trades' programmes.

One hundred and five technical and Mathematics teachers, selected from the participants at the National Board for Technical Education (NBTE) Seminars, provided the data used in assessing the teachers' perception. Five professional Mathematics graduate teachers with sufficient technical background and Five professional graduate technical teachers' from each of the three major technical trades (Building, Electrical and Mechanical) examined the usefulness and extent of utility of 50 mathematics topics considered *necessary* for the mastery of the contents of the technical trades[1] programmes. The instruments used included the Mathematics Curriculum Evaluation Questionnaire (MCEQ) and a list of Mathematics topics. The MCEQ is a 42 - item, 3 point likert type instrument containing six a priori

scales with high reliability Coeffioient. The list of Mathematics topics has 50 items considered necessary for the mastery of the trades' contents of the technical college programmes! Statistical analyses included the analysis of variance (Fixed effect, mixed effect and Factorial design) with repeated measures and the Cochran test.

The following major results were obtained, (l) significant differences were obtained from the perception of the teachers among the six curricular issues. (2) The two groups of teachers concerned with mathematics differ significantly in their perception on each of the curricular issues. (3) Statistically, no significant differences were found between the professional and non-professional technical teachers. (4) The effect of the interaction of programme by qualification was found to be significant (5) The programme effect was significant on the technical teachers[1] perception. (6) The Cochran test indicates no significant difference among the teachers[1] assessment of the utility of the selected mathematics topics in the mastery of the technical trades' programmes. (7) The content of the TCMC was found to bo adequate in meeting the mathematical needs of the technical college students.

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ABBREVIATIONS AND DEFINITION OF TERMS

These terms and abbreviations have the following meanings as used in this study.

ANTC – Advanced National Technical Certificate; The proposed Certificate of the National Board for Technical Education to replace the current WAEC(TECH)/CGLI Technicians' Certificates, which will be awarded to those who will successfully complete their post-NTC qualification training in a technical college.

Artisan – This refers to a semi-skilled craftsman whose trade skills are not developed to the level of a Craftsman. He has the practical skill but lacks the theoritical background.

BD. – Building Trades; this refers to technical college programmes classified under Building trades, for example; Blocklaying and concreting, painting and decoration, etc.

CGLI – City and Guilds of London Institute. A British Professional body that conducts professional technical examinations for technical colleges in Britain and British colonised countries.

Current Students - All the students of technical colleges who are undergoing training in a technical college to become skilled craftsmen.

EL - Electrical Trades; these are technical college programmes grouped as Electrical trades, for example, Electrical Installation, Radio and Television work (Electronic), etc.

Federal Craft Certificate - This certificate is one of the three Certificates awarded to those who successfully complete technical colleges by the Federal Ministry of Education.

FTC - Full Technological Certificate, the highest certificate awarded by the City and Guilds of London Institute, It is professionally equivalent to the HND.

HND - Higher National Diploma, the highest certificate awarded by the Polytechnic or post-technical college Institutions.

ICME -	International Congress of Mathematics Education, a meeting of Mathematics Educators all over the world, held once in every four years.
JAMB -	Joint Admission and Matriculation Board, the body charged with the responsibility of conducting first degree admissions into Nigerian Universities.
Labour Trade Test I, II, and III.	These certificates are awarded by the Federal Ministry of Employment, Labour and Productivity to practically qualified skilled artisans according to the level of competency manifested.
Mathematics Topics -	These are items included in the list of mathematics concepts, processes and skills considered necessary for the study of the technical trades or programmes.
MCEQ -	Mathematics Curriculum Evaluation Questionnaire
ME -	Mechanical Engineering Trades; these are technical college programmes classified as mechanical trades, they include mechanical Engineering craft practice, welding/ fabrication among many others.

MT - This refers to Mathematics Teachers Teaching Mathematics in a technical College.

NBTE - National Board for Technical Education, a body charged with the responsibility of accrediting programmes and maintaining standards in technical institutions in Nigeria.

NCE(TECH) - National Certificate of Education (Technical) the Diploma awarded by the Advanced Teachers' Colleges, or Colleges of Education or Polytechnics, in Nigeria for professional trained technical teachers.

NERC - National Education Research Council.

NTC - National Technical Certificate, The NBTE's proposed certificate to replace the current WAEC (TECH)/CGLI Parts I and II which will be awarded to those who will successfully complete their 3-year training in a technical college.

OND - Ordinary National Diploma, a Certificate awarded by tertiary institutions like Polytechnics.

Perception - This refers to the Mathematics teachers' and Technical Teachers' knowledge, understanding and their conception of the six curricular issues raised on the New Technical College Mathematics Curriculum as measured by the MCEQ.

Secondary Technical School - These are comprehensive Secondary Schools offering some general technical courses such as woodwork, metal work, basic electronics, etc. which are taught as components of general education designed for Secondary Education. The products of such courses can only appreciate that such subjects exist, they do not receive sufficient training to master skills for either private or public employment.

SSSMC - Senior Secondary School Mathematics Curriculum.

Teachers Grade II Certificate - The Certificate awarded to those who successfully complete the teachers' grade two colleges. It is equivalent to the WASC.

Technical Colleges - A 3-year post-Junior Secondary School Institution that offers vocational and technical courses which lead to the

acquisition of knowledge as a craftsmen or master craftsman depending on the level of training.

TCMC - Technical College Mathematics Curriculum, a mathematics curriculum recently developed by the NBTE which will soon be introduced in technical colleges.

TT - Technical Teachers teaching the various trades' subjects in technical colleges.

TTC - Technical Teachers' Certificate, a certificat awarded by post-technical college institutions. It is awarded to those technical personnel, who have successfully completed a one year technical teacher programme in such institutions. It is similar to PGDE.

Trade - This refers to a technical discipline or area of specialisation.

Trainees - Students undergoing professional training in a specialised trade in a technical college. It has the same meaning as current students

WAEC	–	West African Examinations Council.
WAEC/ (TECH)/CGLI Part I and II		These are currently the certificates awarded after the successful completion of the second and third year in technical colleges: it is examined by WAEC in-collaboration with CGLI.

Chapter 1

INTRODUCTION

1.1 Historical Background

Government involvement in technical education dates back to 1948 when the Yaba Trade Centre, now Federal Technical College, Yaba, was established. Prior to that date, and indeed dating back to the beginning of formal Western Education in Nigeria, the historical development of technical education in Nigeria could be traced to Nigerian Railway Training Centre in 1901 (Fafunwa, 1974). Prior to 1948, there had been some uncoordinated and haphazard attempts at incorporating technical subjects in the school curriculum. Taiwo (1974) asserted that among the early efforts were the Bonny Government School and the Hope Waddell Institute, Calabar, where the curriculum included Carpentry, typewriting, printing, tailoring and others.

Such early and commendable experiments by the individual Missionary and Government Schools remained isolated in spite of the Government grant-in-aid for agricultural and industrial activities in schools (Pogoson, 1987). According to authors like Fafunwa (1974) and Pogoson (1987), the reasons for this situation, among others, were the transplantation of the rigid British Grammar School system with its almost

exclusive literacy curriculum; lack of the expensive infrastructure and specialists staff to teach technical subjects even when such subjects existed on the curriculum; the perception of the Secondary Schools' role as that of training for the Universities coupled with the examination syllabuses which were geared towards satisfying University requirements. Even when Vocational subjects were taught, they were not regarded as being on the same footing as subjects for the University entrance examination (even today, the Joint Matriculation Examination conducted by JAMB for admission into Nigerian Universities has no single technical subject) and as a result students and their parents seem to have avoided them. Lastly the lack of nationally - accepted set of goals for Secondary Education other than a preparation for the University admissions, not to talk about the technical education that was not in existence then.

In the 1950's, there was the colonial Government effort to rectify the situation which culminated into the establishment of Trade Centres at Enugu in 1950 and Sapele in 1955. There was also the establishment of Secondary Modern Schools and experimental Comprehensive Schools. The present technical colleges are evolved from what used to be known variously as trade centres, technical schools or technical training schools.

At the threshold of political independence in 1960, there was pressure for "economic, social and educational independence". The educational system still remained so chaotic and with an output that could hardly meet a fraction of the projected development needs of the emerging Nigerian Nation (Ighaho, 1985). Fagbulu (1983:23) in support of this setting, clearly asserted that:

> If education had been expanded more generously and with less concern for employment oppurtunities, the presence of a pool of trained boys and girls would have stimulated more rapid growth, both of the economy and the development of special skills badly required by that sector for the transfromation of the society.

This is further demonstrated in the pattern of educational changes from the past two or three decades. The oil boom of early 1970 s brought a tremendous expansion and enrolment in the number of Secondary Schools. The NBTE's (1984) "Digest of statistics on technical education in Nigeria" clearly examplifies this point. The record shows that the average ratio of enrolment in technical colleges to secondary schools stands at 1:131. If the usual ratio of one technician to seven craftsmen is to be achieved, for the 60,000 enrolment in technical programmes in the Polytechnics, the Nation's technical colleges should be enrolling 420,000,

trainees (Yabani, 1987). Compared with the 57,000 enrolment, the need is simply a drop in the ocean. Also, the introduction of the Universal Primary Education (UPE) programme in 1976 necessitated the expansion of Grade II Teachers' Colleges. The number of such colleges rose from as low as two in some states to at least one per local government area in all the states of the Federation. It seems that the technical colleges, as compared to the Secondary Schools and Grade II Teachers' Colleges, enjoyed little or none of this educational boom. In the north, most of draft schools (the then Junior Technical Schools) instead of being upgraded to technical colleges, were converted to either secondary technical schools or Government Colleges. Some examples were Soba in Kaduna State, Makurdi in Benue State and Pankshim in Plateau State. The situation of technical education in Nigeria is best summarised by Adaralegbe (1983, 6) in this way:

> It is sufficient to remark in passing that notwithstanding the establishment of 'Modern Schools' in the defunt Western Region of Nigeria (1955-1979), the opening of technical secondary schools by the Federal and State authorities, as well as the creation of Trade Centres/ Schools throughout the country, technical education for rural development and the fostering of a technological awareness has hardly received any meaningful boost, let alone a successful and noticeable take off in Nigeria yet.

However, to discuss technical education at the craft level, its philosophy can now be viewed as an integral part of the Nigerian philosophy of Education as outlined in the National Policy on Education (1981) with clearly articulated objectives.

1.2 Background Of The Problem

The expansion in Secondary and Teachers' Colleges was coupled with curriculum expansions and reforms. While the number of subjects offered increased, the contents of the subjects were continuously being reviewed and modified to meet new challenges and demands. For example Mathematics Curriculum for Secondary Schools changed from Traditional Mathematics syllabus through the "Modern or New Mathematics" approach to the present mathematics syllabuses (JSS and SSS) produced in 1979. The same trend affected the Primary Schools and the Teachers' Colleges' Mathematics syllabuses: from the arithmetic syllabus of the 1960s to the 1979 mathematics syllabuses. Even the 1979 Grade II Teacher Education Mathematics Curriculum is currently under review to fit into the 6-3-3-4 system of education. Furthermore, there were the additional mathematics (now Further Mathematics) and statistics syllabuses for Secondary Schools, and optional mathematics for teachers colleges. On the other hand, Kyeleve and Oguntchi (1987a)

and Shirley (1987) have observed that there has been no specific mathematics curriculum specifically meant for Nigerian Technical Colleges. But the importance of Mathematics in Technological Development is not in doubt. This has necessitated the study of the subject at all levels, in all vocationa/technical courses of technical institutions.

From all available evidence, the mathematics curriculum in use in Nigerian Technical Colleges has been the Secondary School one. However, the National Board for Technical Education (NBTE) has now been paying particular attention to this important sector of education. The Board has been involved in restructuring the curriculum of existing technical college programmes and developing new ones to meet the present and future skill requirement of the nation. These syllabuses are to be introduced during the 1989 academic year (Yabani, 1987).

1.3 Statement Of The Problem

In most cases, as pointed out in the proceding section, it is usually the secondary school curricula in subjects like mathematics, physics and English language that get transplanted to the technical colleges in Nigeria. It is obvious that such a situation does not urger well for

technical education. This is basically due to the fact that the philosophy and objectives of technical education are substantially different from those of the secondary education. This has justified the development of a separate syllabus for technical colleges to meet these objectives.

The NBTE's newly developed syllabuses include those for mathematics, integrated physical sciences, social studies, English language, technical drawing, descriptive geometry and the various trade programmes of specialization. These subjects will be examined under the National Technical Certificate (NTC) and the Advanced National Technical Certificate (ANTC) which will replace the current WAEC (TECH)/City and Guilds Parts I and II at the Craft level and the Technicians/Full Technological Certificate at the Technician's level. The Federal Craft Certificate will be abolished in the new set up. Unlike the WAEC (TECH)/ CGLI syllabuses which contained merely the list of topics/ practical activities to be covered, the NTC and ANTC syllabuses are prepared in module specifications and are spelt out in behaviourial objectives. The objectives are intended to be capable of having only one interpretation. Teachers are expected to provide evaluation at the end of every module. Furthermore, unlike the WAEC (TECH)/CGLI examinations which cover only the trade area of

specialization, the NTC and ANTC examinations will cover all the general education courses and the technical areas of specialization. Infact there are other several differences in the new curricula as compared to the WAEC (TECH)/CGLI syllabuses which will culminate into placing high demands upon the teachers.

With the proposed innovation to develop and adopt an ideal technical college curricula materials and the demand placed upon the teachers, what are the teachers' perception of these new materials with particular respect to mathematics? Several studies and writers like NERC (1977:12), Eichholz and Rogers (1973:307), Wawes (1979:119) Emeruwa (1981:66) and Onwuka (1985:25) among others, have indicated that teachers do not often perceive the underlying philosophy, objectives, assumptions and design of these materials; thus resulting in their resistance to the innovation.

Consequently, the major concern of this study is to evaluate the teachers' perception of the new Technical College Mathematics Curriculum as well as to undertake a detailed content analysis of the mathematics curriculum to assess whether it will meet the mathematical needs of the technical trainees.

1.4 Purpose Of The Study

The major purpose of this study is to assess the teachers' perception of the new technical college mathematics curriculum in terms of six curricular issues of concern. Following the Badrus (1985:86) approach, the study will specifically assess the teachers' perception with respect to:

1. the extent to which the mathematics curriculum meets the general objectives of teaching mathematics at this level and type of education;
2. the extent to which the instructional objectives relate to the general objectives of teaching mathematics and the extent to which they are attainable;
3. the relevance of the content of instruction;
4. the adequacy of balance and scope of the content;
5. the reasonableness of the organisational structure of the content of instruction; and
6. the feasibility and applicability of the teaching-learning strategies.

Another purpose of the study is to assess the effect of teachers' qualification (two levels) and the type of programme (three levels) on the perception of the teachers on the technical college mathematics curriculum.

It is the researcher's intention to determine the mathematical topics mostly required and commonly employed by technical college trainees and graduates in the study and practice of their trade of specialization; and thus assess the topics commonly employed in the study of the various trade areas in technical colleges. The study will equally assess the adequacy of the content of the mathematics curriculum.

1.5 Justification And Significance Of The Study

Several Mathematics Curriculum studies carried out, such as those of NERC (1977), Ohuche (1978), Osibodu (1976), Igboko (1973), Badmus (1977, 1986), and Williams (1974) among many others were directed towards Secondary Schools, Grade II Teachers Colleges or Primary School Education. The curriculum studies for technical education seems almost completely unexplored in Nigeria. Literature search has confirmed that little or no research work has been done on mathematics curriculum for technical colleges. There have been only four types of Mathematics Curriculum, meant for Primary Education, Junior Secondary Education, Senior Secondary Education and Teacher Education, in the country. Though technical education at the technical college level is clearly enshrined in the National Policy on Education (1981, Section 45), with clearly articulated objectives

and projected implementation guidelines, there has been no mathematics curriculum specifically prepared for technical colleges until this present effort. Thus, this study is designed to provide a pre-implementation illuminative evaluation of the varying perceptions held by the different participants, involved in technical colleges, towards the new technical college mathematics curriculum.

Badmus (1985:41) quoted Le ~~wy (1977)~~ as saying that "the benefit to be derived from pre-implementation study of this type include, the identification of problem areas which may lead to modification of approaches to implementation." The study could also help in identifying needed areas of training and re-training of teachers and highlighting of needed revision. The study will equally highlight other related issues and determine whether the new Technical College Mathematics Curriculum will meet the Mathematical needs of the teachers, technical trainees and future graduates.

The findings of this study will be of help to policy makers especially the NBTE with respect to the Mathematical aspects of technical colleges in particular and technical education in general. Finally, the study will provide a frame work for future similar research

efforts in the other general education (supportive academic) subjects such as English language, Integrated Physical Sciences and Social Studies offered or to be offered in Technical Colleges.

1.6 Research Questions

This study will attempt to provide answers to the following questions.

1. What are the characteristics (such as basic educational background, basic qualification, the distribution of the teachers by age and sex) of the Mathematics and Technical Teachers teaching in Technical Colleges?
2. What are the types and ages of the Mathematics Curricula currently in use in Nigerian Technical Colleges?
3. Are the views of the mathematics and technical teachers on the identified areas of the new TCMC the same?
4. Do the teachers' qualifications have any influence on their views?
5. Are the views of the technical teachers the same irrespective of the major types of programmes they teach?

6. To what extent will the views of the teachers on the utility of the selected mathematics topics depend on their areas' of specialization?

7. Will the mathematics curriculum meet the needs of the technical trainees?

1.7 Research Hypotheses

In order to answer some of these research questions, the following research hypotheses will be tested in this study. The first and second hypothesis are designed to test the .perception of the two groups of teachers that have direct dealings with mathematics in the technical college programmes. The third and fourth hypothesis are designed to test the effects of programmes and qualifications on the perception of the teachers. The fifth hypothesis is to test the interaction effect of the programmes by qualification on the technical teachers' perception. The sixth, hypothesis will test the assessment of the selected teachers in assessing the utility of the selected mathematical topics in the study of the three major groups

of technical trade programmes: Building, Electrical and Mechanical trades.

Ho1: There will be no difference in the perception of the teachers on the six curricular issues raised on the TCMC as measured by the modified MCEQ.

Ho2: There will be no significant difference between the perception of the two groups (MT and TT) of teachers on the six curricular issues raised on the new TCMC.

Ho3: The technical teachers' qualifications will not significantly affect their perception on the six curricular issues raised on the new TCMC.

Ho4: The technical teachers' major area of specialization (Building (BD), Electrical (EL), and Mechanical (ME)) will not significantly affect the teachers' perception on the six curricular issues raised on the new TCMC.

Ho5: There will be no interaction of programmes by qualifications among the mean perception of the technical teachers on the six curricular issues raised by the MCEQ on the new TCMC.

Ho6: There will be no significant difference among the Mathematics; Building, Electrical and Mechanical trades' teachers in their assessment of the utility of the selected mathematics topics in the mastery of the technical trades' programmes.

1.8 Scope And Delimitation Of The Study

This study will focus mainly on the teachers' perception of the NBTE's recently developed TCMC to be introduced in the Technical Colleges during the 1989 academic year. The study will cover all the technical colleges in the country. The non-delimitation of the coverage to specific colleges in specific states is principally due to the cost advantage and proximity of the series of National Seminars organised by the NBTE for

the heads of departments of the various programmes in all technical colleges in Nigeria. These seminars took place between 2nd February to 21st April 1988. Besides, most of the technical colleges in the country have much in common with particular respects to the subjects studied, examination structure and certification. The areas of interaction between mathematics and the other trade subjects will be exploredbut there will be no further detailed study of such areas.

This study is delimited to the mathematics curriculum designed for the 3-years, post Junior Secondary Schools, Technical Colleges who currently sit for the WAEC (TECH)/ CGLI Parts I and II Examinations. Other NBTE Mathematics Curricula of technical institutions offering programmes below and above this level are not examined in this study, such as the trade centres, VTCs' and technical colleges offering the technicians' programmes.

Feed back was sought from the mathematics and technical teachers in the technical colleges. No effort was made to seek feedback from the trainees, past graduates and teachers in the other supportive courses. The study did not assess the current status of the mathematics subject in these colleges. It, however, attempted to identify the types of mathematics programme(s) in use in technical colleges.

Finally, except for qualification and the major areas of specialization, other factors affecting the teachers' perception were beyond the scope of the study.

1.10 Summary

In this chapter, a brief historical development of technical colleges and the current status and problems of these colleges have been outlined. The slow pace of expansion in technical colleges as compared to its equivalent educational levels (Secondary Schools and Grade II Teachers' Colleges) as well as the non-expansion and reforms of curricula programmes have been provided as background information. This has then led to the articulation, identification and definition of the problem of the study. The purpose, justification and significance of the study are equally articulated. Several research questions and hypothesis are raised which the

study hopes to provide some answers and test respectively. Finally, the scope, delimitation and the basic assumptions of the study are specified. As the tradition demands, the next chapter covers the review of related literature in this field of study.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Literature search reveals that there is little or no published work on technical education in general and mathematics curriculum studies in particular, for the Nigeria technical education. However, it is observed that several studies in mathematics curriculum and teachers' behaviour in educational innovations in other types of education have been carried out both in Nigeria and elsewhere. It is further observed that several studies in mathematics for this level and type of education have been investigated in other parts of the world. Mays (1952:576) expressed the lack of research work in technical education and advanced some reasons for this as follows:

> The amount of such research has not been large, due chiefly to the relatively short time since the establishment of industrial education as an organised school activity and to the slow development of colleges and universities for graduate work in this area.

Though this statement was expressed 36 years ago, it is still relevant for the present day situation in Nigeria.

Maclennan (1959:17) equally acknowledged the lack of scientific and technological research in technical colleges. Though the idea has been accepted when he remarked that: "educational research in technical colleges has not attracted the same emphasis." This was as compared to other educational institutions. The reasons and situation described above for lack of research in technical education seem to be very much applicable to today's Nigerian technical educational scene. Several researchable areas such as selection of courses, variety of classes, teaching methods among others exist in technical education (Maclennan, 1959). He went further to contend that "variety of classes poses the greatest problem confronting the technical teacher at the lower level". He feels that everyone knows it exists and yet, it is perpetuated from year to year. He argued that "it is only in technical education that the student is the victim of imponderables."

Consequently, the bulk of the literature relevant to this study spans from the late 1950's and is based in other types of educational institutions. Further, most of the studies reviewed in technical education are based on the tradition in the United States of America, European countries and some Asian countries. It is then pertinent that one can only relate the implication of these studies

and reports to the situation in Nigeria technical colleges in general and the current study in particular. The selected literature is presented under the following six headings:

1. Models of Curriculum Design and Studies in curriculum issues.
2. Studies in Curriculum Innovations: the process and the teacher factors.
3. The General Context/Programme Activities of Technical Colleges.
4. Studies in Technical Education.
5. Mathematical Studies in Technical Colleges.
6. Related Studies in Other Disciplines.

2.2 Studies In Curriculum Design And Curricula Issues

There are various models of curriculum design given by different writers and authors. However, most of these designs have much in common. The steps involved in some of these models are merged in others. They differ mostly in the use of terminology.

Omukwa (1984:42) outlined four major steps involved in the curriculum (Development) planning process as follows:

1. Determination of aims, goals and objectives;
2. The selection of appropriate learning experiences and the subject matter content;
3. Organisation and presentation of the selected learning experiences; and
4. Evaluation of the learning outcomes.

According to him, these steps are interdependent. While he described the general objectives as "the described school outcomes", he termed the specific ones as "described behaviour to be attained." In the TCMC, the specific objectives are coined as performance objectives. These two types of objectives seem apparently manifested in the new TCMC. Objectives are meant to change individuals in some desirable way, to add to the knowledge they possess, to enable them perform skills which otherwise they would not perform, to develop certain understandings, insights and appreciation.

Among the functions of objectives as identified by Omukwa (1981:81) are: "to help select content and desirable learning experiences; and that they form one of the major bases for evaluation." Factors that affect learning experiences are validity, relevance to life, variety,

suitability and cumulation. Onukwa (1981:87) described content as the "knowledge, skills, concepts, principles, attitude and values to be learned." According to Nicholls and Nicholls (1972), Criteria which content has to satisfy for selection include Validity, Significance, Utility, Interest and Learnability.

Onukwa (1981:9) believes that "organisation of learning experiences is a crucial task in curriculum development because it greatly influences the efficiency of instruction and the amount of learning that takes place in any educational setting." He went further to cite three criteria to be satisfied by an effective group of curriculum experiences as "continuity, sequence, integration and evaluation.' It is through evaluation that the success or needs for revision of a curriculum are established. Most of the cited criteria have formed the basic items of the instrument to be used for assessing the teachers perception.

Havelock (1971) curriculum design model as reviewed by Shirley ('34) has three steps: Research, Development and Diffusion (R, D and D). It is obvious that the steps in Onukwa ('81) model are basically contained in the development level of that of Havelock. In the Havelock model, Research entails basic research to identify the

problems and offer some suggestions to developers. This leads to the development of ideas for use which are well covered in Onukwa's (1981) model explained above. Diffusion is the dissemination of these developed ideas (curriculum) to the schools (recipients). This last step will be taken up in detail in the next section.

Hawes (1979:33) advanced six steps involved in planning curriculum change as follows:

1. Gathering information on the context,
2. Deciding the aims and objectives,
3. Planning a strategy of change. This entails manpower, materials and time,
4. The actual curriculum development,
5. Implementation in schools, and
6. Evaluation.

Hawes (1979) felt that most curriculum planners do less on the first step as compared to the other steps. The second, fourth and sixth steps of Hawes model seem well reflected in Onukwa's (1981) model. However, the evaluation step in the Hawes (1981) model is meant to be carried out in all the other five steps. It seems that the first four steps have been executed by the National Board for Technical Education (NBTE) with respect to the new mathematics curriculum planned for Technical Colleges.

It is, however, difficult in assessing the adequacy of coverage of the third steps. But the curricula are ready for step 5: Implementation in schools. This is confirmed by the NBTE Executive Secretary, Yabani (1987:5) when he said that; "the syllabuses for the new National Technical Certificate (NTC) and the Advanced National Technical Certificate (ANTC) developed by the NBTE will be introduced in the 1988-89 academic session."

2.3 Studies In Curriculum Innovations: The Process And Teacher Factors

Onukwa (1981) identified three basic elements in the educative process of curriculum design. These are the society, the learner and the teacher. The needs of these groups are very crucial in curriculum planning. Mackenzie (1964), on the other hand, identified six determiners of the curriculum as follows: teachers, students, subject matter, methods, materials and facilities; and time. According to him, all these are influenced by the cultural context in which they operate. These determiners are usually the targets of change. According to Mackenzie (1964; 406), "the six determiners vary in their significance from one instance to another. Yet there may be many situations in which the neglect of one or more of the determiners may lead to failure to bring about desired change." Some of these needs, are reflected in the paper by Towo' (1987:2),

who is the director of programmes, NBTE. He pointed out that, the determinants of the curricula of the technical colleges developed by the board included "the needs of the society, the needs of the individual students; and the demand of the discipline of knowledge."

In fact, there seem to be several examples of curriculum that have been developed and introduced that have not last long. The Entebbe Mathematics and the Modern Mathematics among others seem typical examples of such attempts at curriculum renewal. In an answer to the question: Why have some curriculum revision or change not taken root, while some others have? Okoko (1981:114) identified certain factors that must be considered for any curriculum renewal to be effective. These factors centre around the teacher and resources. She felt that a "genuine innovation does not occur unless teachers become personally committed." She reasoned that, "because new curricula or even new methods call for knowledge, understanding and other abilities that the majority of teachers do not possess, a well-designed curriculum may fail to be adopted or even be condemned." Sometimes the language used may present some misunderstanding. In this study, the teachers knowledge and understanding of the new TCMC will be assessed. Shipman (1974:28) commented on the assumptions which are wrongly made that "the teachers in general are reading widely in the theory and practice of their own subjects."

In the same spirit, Onukwa (1981) and Wain (1975) identified teachers as the key factors in the operation and for the success of curriculum. They felt that teachers are indispensable in the educative process. In the words of Onukwa (1981:65): "In the final analysis, it is the teachers who not only determine what actually is to be learned but also largely control the learning experiences that go on in the classroom." To Onukwa (1981:66): "Teachers who have the responsibility to implement a proposed curriculum do not function with a blank background. They have their personal values and notions about how education should be oriented. These values and notions can hamper their proper understanding of the central curriculum intentions." It is these personal values, and notions held by the teacher that this study aims at assessing with respect to the new Technical College Mathematics Curriculum (TCMC). It is Oladele's (1985:49) feelings that "no new curriculum can achieve the desired result unless among other factors, the teachers to implement it are appropriately trained and properly initiated into it." On the status of teachers in curriculum implementation, Oladele (1985:51) again, strongly argued that:

> There is no doubt that the successful implementation of any new educational programme, be it for primary, secondary or technical institutions, depends, among other things, on a sound and appropriate teacher education programme as expressed in the NPE that 'no education system can rise above the quality of its teachers.'

Besides the teacher factor, the organisational structure of schools' control and management equally has bearings on curriculum innovations. This factor also seems well reflected in much literature on the dissemination of new curriculum or curriculum revision. It was Layton (1978:114) assertion that:

> The varying perceptions of innovations held by different participants appears to be one common element in a number of accounts of 'innovations without change'. Many proposed innovations entail substantial organisational changes and attitude shifts which are not easily achieved. Classes may be formally constituted as 'de-streamed' but teachers still 'stream' in the mind; subjects teaching may be replaced by integrated studies of one sort or another, but boundary disputes and teacher status anxieties often follow in the work.

In this study, it is such varying perceptions of the technical and mathematics teachers in the proposed change in mathematics that are of interest and will be assessed. It is obvious from the foregoing that the choice of the

teacher as the central variable in this study is not out of context. Layton's assertion seems true of the new technical colleges curricula been developed. The design of the new curriculum as compared to the previous one, is different, and it is prepared in module specifications. Physics is replaced by Integrated Physical Sciences. The structure of evaluation and certification is completely different.

Discussing the diffusion of new ideas, Howson (1978: 124) gave its two meanings as 'spreading' and 'intermingling'. These two meanings are of equal importance in education. He wrote that:

> New ideas are not fed in a vacuum; the teacher or person introduced to the new idea already possesses certain beliefs and will automatically integrate the new concept in terms of his traditional pattern of understanding. One gets intermingling of ideas, a diffusion, with frequently an unexpected or even undesirable result. Such a misinterpretation of new ideas is not new.

On the system of curriculum control, Howson (1978:131) felt that: "centralised control of curriculum, although perhaps discouraging innovation and independent action, does ensure that new ideas and methods are more readily disseminated." He suggested that, "in this case, it is, however, vital that adequate provision is made for

in-service training." He forcefully argued that, "new ideas are best assimilated by well-trained teachers. Only they will be competent to reject the bad and welcome the good, and to remedy deficiencies in new materials." The implications of Howson's remarks are obvious given the nature of control of the curriculum under this study. This curriculum among others is developed by the National Board for Technical Colleges (NBTE) to be used in all technical colleges of Nigeria. This model of curriculum making is what Badmus (1985:39) quoted Skilbeck (1973) as termed "rational deductive decision making which takes effect in a centrally dominated curriculum system." As if to confirm this, the director of programmes NBTE, Towe (1987:11) wrote:

> With the promulgation of Decree 16 of 1985, the Board is not now only just establishing minimum standards of technical education, it is also the quality control agency for technical education in the country, outsides the universities. In this regard, it has responsibility for accrediting programmes in technical colleges before they enter their students for any national examination. The scheme which shall take off with advisory visits soon will be based on the provisions of the Boards National Standards for Technical Colleges and the new curricula and course specifications for the new certification system to be introduced.

Badmus (1985:40) gave the greatest weakness of this mode of curriculum control as being that: "teachers merely act as functionaries in a bureaucratic system and play a very limited part in the system and thus play a very limited part in the curriculum development activities." He, however, suggested that; "this limited role of teachers is often justified by lack of sufficient knowledge of curriculum development on the part of teachers." But the teachers' role in curriculum implementation as earlier reviewed above is very crucial. It must be mentioned at this point that the models of curriculum diffusion are not discussed since this study is a pre-implementation one. However, from the series of seminars planned and used for the dissemination of the curricula materials to the technical college teachers, the NBTE used what is termed "the central periphiral approach." It is, however, necessary at this point to review the existing context and programme activities of technical colleges to highlight the proposed change.

2.4 The General Context/Programme Activities Of Technical Colleges.

In the present 6-3-3-4 structure of education, technical colleges will have the senior secondary schools and the Grade two teachers' colleges as its equivalent level of education. As pointed out by Safolahan (1987:7),

Kycleve and Oguntebi (1967a: 12) and Pogoson (1987), they will take the second 3 in the 6-3-3-4 system. The objectives and aims of technical education, irrespective of the level it is provided, are outlined in the National Policy on Education (Section 6:49) as follows:

(a) to provide trained manpower in applied Science, technology and commerce, particularly at sub-professional grades;

(b) to provide the technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development;

(c) to provide people who can apply scientific knowledge to the improvement and solution of environmental problems for the use and convenience of man;

(d) to provide an introduction to professional studies in engineering and other technologies;

(e) to give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and self reliant, and

(f) to enable our young men and women to have an intelligent understanding of the increasing complexity of technology.

From the above, technical/vocational institutions in Nigeria in general are expected to play three roles. They should provide:

(i) Vocational courses intended to meet the occupational interests and career needs of the individual.

(ii) Manpower training programme intended to meet social and economic policy goals of government, and

(iii) Industrial training programmes intended to meet the skill needs of employers.

The above objectives and roles of technical colleges will be provided as background information to the teachers who will form the sample of this study.

Technical Education as argued by Sofolahan (1986:6), like most educational programmes, has three major aims - the cultural, disciplinary and the utilitarian. According to him, "exposure to technical education gives one some knowledge that one would otherwise not have had, given rise to the cultural aspect; while the behaviour patterns of materials and their responses to different treatment is bound to instill some discipline into the observer." In fact, vocational courses offer a discipline of their own from which man has a lot to learn. The utilitarian aim is obviously not in doubt.

To achieve the above aims, technical colleges in Nigeria, as shown in the NBTE's (1985:89-169) report offer about twenty-eight (28) different trade programmes under the following four major groupings.

(a) Mechanical Engineering Trades:

Motor vehicle mechanic work, welding, Metal Fabrication, Mechanical Engineering Craft, Instrument Mechanic, Foundry, Agricultural Mechanics and; Vehicle Body Building and Panel Beating and Spray Painting.

(b) Electrical Engineering Trades:

Refrigeration and Air-conditioning, Electrical Installation, Telecommunication, Radio and Television, and Auto Electrical.

(c) Building Trades:

Blocklaying and Concreting, Carpentry and Joinery, Plumbing, Painting and Decorating, Furniture and Machine Woodwork, and Architectural Drafting.

(d) Business Education And Others:

Typing and Shorthand, Book-keeping, Home Economics, Hotel and Catering, Footwear and Leather Craft, Ceramics, Photography and, Printing and Graphic Arts.

Kyelcve and Oguntebi (1987b:4) and Pogosan (1987:7) have described the four core subjects currently offered in technical colleges as follows:

- Trade of specialisation with four sub-units as Workshop practice, Craft theory, Craft Science and Calculation, and Trade Drawings.
- English language
- Mathematics, and
- Physics or Basic Science.

The trade of specialisation could be any of the twenty-eight trade programmes outlined above. This study will focus mostly on the technical teachers in the first three major trade areas: Mechanical, Electrical and Building trades. This is mainly due to the few technical colleges offering business education courses. Bedises, business education courses were not covered in the NBTE's series of seminars for the heads of departments.

In technical colleges, there are presently three different types of examinations conducted by different bodies. The first is the WAEC (TECH)/City and Guilds of London Institute parts I and II. These examinations are taken at the end of the second and third year respectively in the 3-year programmes offered in Technical Colleges.

This examination covers only the trade of specialization. The second is the Federal Craft Certificate Examination which is internally examined by the college or centrally at the state level and cover all the core-courses. The third is the labour trade test Grade II, conducted by the Federal Ministry of Labour, Employment and Productivity. It covers only the trade theory and workshop practice. Like the Federal Craft, the trade test is usually examined at the end of the programme. The New Curricula developed by the NBTE include courses in the Trade of Specialisation, English language, Mathematics, Social Studies, Technical Drawing, and Integrated Physical Sciences. These courses will all be examined under the National Technical Certificate (NTC) and the Advanced National Technical Certificate (ANTC) to replace the WAEC (Tech)/CGLI Parts I and II. The Federal Craft Certificate and the Labour Trade tests will be meant for semi-skilled craftsmen or artisan on successful completion of their training in trade or vocational centres.

2.5 Studies In Technical Education

Walker (1960:4) in a review of Hinninger's report on the technical institutes in America and its implication in engineering education was of the opinion that, there should be equal recognition attached to the entire spectrum

of technical education. He advanced his contention in the following words:

> A structured system of technical education of this sort is workable only so long as we honor all parts of it. It cannot work if we stigmatize some of its parts as being inferior to certain other of its parts. A student is not willing to enter a programme that he knows is considered inferior, even if it happens to be the programme best fitted for developing his particular interest, abilities and ambitions.

He further remarked that "it is necessary to have both plumbers and philosophers; and that unless quality education is provided for both, neither our pipes nor our ideals will hold water."

In a related review with implication for industries, Leaner (1960:1, 4) argued that the shortage of scientists, engineers and technicians was not a scarcity of individuals but the shortage of fully educated potentials in these fields. He identified one impact of the report on the industry as it related to the engineering team: engineer, technician, and craftsman. He equally lamented over the acute shortage of these personnel and identified some aspects of the curriculum that the industries needed: "Public education should, however, provide students with

a high degree of proficiency in their chosen broad fields of technology, solidly supported by technological principles, sound working knowledge of mathematics, basic science and English". From the industrial point of view, when this fails, there is gap which they are forced to fill for such employees. The present efforts all point towards these goals.

The study by Oyenoye (1980:39) on the problem of self-allocation in the planning of vocational education in Nigeria seems to confirm the views expressed by Walker above. The sample of the study consisted of over 400 primary school pupils in four schools randomly selected and stratified by class and location in two Yoruba towns of Oyo and Edo. The instrument used was a questionnaire. The study tested the attitudes of the pupils to vocational training. They were to choose five jobs they liked and five they disliked from a list of twenty. The pupils' educational preference and their dispositions to craft and skilled training were examined.

Analysis of the result shows that as much as 48 percent of the sampled pupils would prefer White-collar Jobs; 33 % aspired to skilled work, 14% to trading; 4% to other manual occupations and only 1% to farming. With respect to the pupils' Socio-economic background, pupils

from the high socio-economic background are least disposed to skilled work. This reflects the perceived opportunity structure available to them and the types of jobs they expect to go into in the future. It is also a reflection of the value-orientation of the pupils' families. Similarly, girls were less interested in skilled work than boys. The pupils main reasons for their preference of White-collar jobs were: Income 30%, the social prestige of the job 27%, working conditions 17:, family influence and advice 2%.

The researcher concluded that pupils paid less attention to their capabilities, national needs and the opportunities of entry into the occupations than to the conditions of the jobs, the prospects of "getting on" generally were viewed in terms of the monetary advantages and the social prestige attached to the jobs. Most importantly, the results show that uncertainty about admission to a grammar school appeared a strong factor motivating the interest of some of the pupils in craft training. Although the subjects used in the study were limited to primary school pupils, there is ample evidence, as pointed out by Kyelcve and Oguntebi (1987a:9) and Towe (1987:4), to assert that the picture is not all that different at the secondary school level. It seems unfortunate that the same perception is held even by policy

makers as could be found in our National Policy on Education Section 19 and 20 that:

> The senior secondary school will be for those able and willing to have a complete six year wecondary education, ... Trade centres and similar vocational centres will also need to be expanded to absorb junior secondary school leavers who cannot proceed to the senior secondary school.

Unfortunately, the last sentence of the above statement suggests that only left overs are good for vocational education. Since the National Policy on Education has continuously been reviewed, there is hope that sections like those quoted above may receive some modification. But the problem with technical education at this level are not new. Yabani (1987:3) lamented over the situation in an address to the "National Workshop on the roles of Technical Colleges in Nigerian Educational scene." He felt that the dearth of skilled craftsmen in the country needs to be emphasized. He further observed that: "right from the beginning, little emphasis was placed on technical education in general. Looking back to our pre-independence era, we have very little to show on this aspect of education." On the existing conditions of technical colleges, he felt that: "Even for the few technical colleges that are presently existing a lot remains to be done if the nation is to make vocational education a tool for national development."

The summary of the current situation of technical education and technical colleges in particular is given in the report of the Federal Ministry of Education on its performance during the fourth National Development Plan period (1981-1986). The report in respect of technical education is nothing to write home about.

In the words of the Guardian (28/2/87) captioned "low marks for technical education," the Editor lamented over the unpleasant contradictions between our professed priorities on the one hand and the neglect of the specific actions needed to realise them on the other. It further stated:

> "The report reserves its lowest marks for the technical colleges of education which it calls "glorified secondary schools" with neither workshops not laboratory facilities."

It seems we need take a cue from the words of Rawlings (1983) who pointed out to his country men that:

> To survive as a nation, production and efficiency must be our watchword. Populist nonsense must give way to popular or unpopular sense ... to scientific and technological sense whether it is popular or not. Many of us have spent too much time worrying about who owns what. But there is no onwership without production first. The only resources which do not have to be produced are those given to us

> by nature and these must be used for the benefit of all the people of today and tomorrow. Everything must be produced and until we all fully recognise and act upon this fact, we shall be deceiving ourselves with empy theories.

The fact from the above is that, all over the world, it is wel-known that education has been used as a tool for national development but what is termed development is a creation of skilled technical manpower of all types. But such a skill cannot be effectively developed without a good background of mathematics. The importance of mathematics in scientific and technological development is not in doubt.

Professor Mohammed (1987), the Vice-Chancellor of Ahmadu Bello University, Zaria, in a wellcome address to the 8th Annual Conference of the Mathematical Society of Nigeria held in Zaria was of the view that: " This nation must realise the importance of mathematics in the scientific and technological progress of the country." At the same Conference, Tafida (1987), equally declared that, it is only when we are able to create an appreciable population of mathematics literates through improved mathematics education offered by members of the mathematical society and other similar bodies that our technological take off can be a reality. Several other studies such as

Wallens (1960:14), Semper (1960:32), Cotterell and Smith (1960:23), among many others on pre-apprentice, apprentice and technical education, have indicated the importance of mathematics in these fields. We shall at this juncture, take a look at the related mathematical studies in this field of education.

2.6 Mathematical Studies In Technical Colleges.

According to Rosenbloom (1983:235), many leading mathematicians like Felix Klien, John Perry, E.H. Moore and Moris Kline have been advocating for a long time the teaching of the application of mathematics. He is of the opinion that the situation still remains unimpressive and lamented over the situation in American Schools with the statement that:

> Some textbooks and other curricular materials have been provided by individuals and groups, yet applications are hardly mentioned in schools. In American Schools, the most widely taught applications are the so-called "Social-applications" ... Even though mathematics is an integral part of most vocational school programmes, the role of mathematics in the skilled trades is not mentioned in school textbooks.

This situation seems virtually identical to the Nigerian technical colleges in which most of the mathematics textbooks hardly contain any vocational or

Trade questions. Rosenbloom further suggested the introduction of application of mathematics into the curriculum by incorporating them into the existing one; that is, to teach the mathematical ideals and their application in close proximity to each other. Here, the role of the teacher readily comes into play. In this regard, Roney (1960:5) outlined the most essential attributes of an effective teacher of technical subject matter as "technical competence, industrial experience and pedagogy." He contended that even though the attributes are not new, there is need to give relative weight to each. These attributes are equally essential to the teaching of mathematics in such technical colleges. Roney further observed that: "Teacher Education programmes designed for other purposes do not provide the technical and scientific background required in this field." This statement is partly true of our teacher education programmes. Except of recent, university teacher education programmes in the country are geared towards the preparation of teachers for teaching in secondary schools and teachers' colleges only. This study will attempt to assess the academic background of mathematics teachers in Technical Colleges.

Fitzgerald (1976:42) conducted a comparative study between the contents of the school engineering craftsmen and Technicians' mathematics syllabus with those of two industrial training schools. Training officers were interviewed to ascertain if any mathematical tests were employed in the selection of trainees. He drew up a list of mathematical concepts, processes or skills which he felt would be desirable for potential apprentices to have met at schools and to have gained some competence referred to as "competence list." This list seemed to be more detailed than the school syllabus. From the interviews, he arrived at some assessment of the levels of competence that industries did in fact accept. The results showed that certain topics such as calculations based on fractions and equations were likely to be met by apprentice and considerable competence is desirable. However, acquintance with several other items (e.g. Pythagora theorem) were necessary but particular application of these mathematical ideals to workshop practice was not expected initially. He noticed that there are some industrial operations with no clearly identifiable mathematical areas. However, there are others with some intrinsic logic and mathematical content in them. He cited the following:

Spatial ideas (reading drawings in first and second angle projection).
Ideas of coord inate (coordinate dimensioning and control board of the plug-programmed Lathe) Addition and substraction of decimals (Feeler guages).
Units of measurements;
Reading scales and interpolation (rule, dias, etc)
Idea of limits (tolerance, GO-NO-GO guages)
Flow diagrams (to describe a particular routine)...

The implications of the study to school mathematics according to him, suggest that all was not well with the teaching of mathematics for industrial workers. He then suggested "a series of graded coupetency tests, starting at a very low level but with high pass marks, so that a pass clearly indicate competence in an identifiable set of items. The evaluation of such a competence will certainly be based on the objective model. The implication of this study to the Nigerian situation is quite clear. However, the teaching of such mathematics in technical colleges faces a lot of potential problems since many mathematics teachers lack the technical background for effective teaching. The WA EC (1982-85) Chief examiner's report shows a consistent non-attempt or poor attempt of questions by candidates on the technical section of the WASC/GCE 'o' level mathematics examinations.

Bereson and Robinson (1982) undertook a study of the mathematics requirements for Israel technicians and practical engineers. The study focused mainly on electronics, electricity and control systems which was examined in the light of their mathematical needs both while in college and on the job. The study also investigated the infleucne of technical advances (computers) on the mathematics employed by technicians and practical engineers in the industry; and changes in the mathematics curriculum in colleges of technology as a result of increasing technological sophistication of local industry among others. The study utilised responsive evaluation and textbook analysis and included interviews with senior personnels in eleven leading Israeli electrical/electronic industries. The result revealed that:

1. the mathematical tools presently at the disposal of technicians and practical engineers in Israel generally meet their day-to-day job needs but the ability to apply mathematical knowledge learned in colleges/or high school is often lacking.
2. Those involved in technological education voiced a need for drastically revamping the technical high school mathematics programme, including a sharp reduction in time devoted to logarithms and

trignometric computations, exploitation of hand calculators and an earlier introduction to logic, matrices, determinants, boolen algebra and differential equations.

3. The correlation between the formal study of mathematics and its application to technical subjects was unsatisfactory.

The researchers felt that this findings were due to the fact that: "the secondary school mathematics programme may be appropriate for the university bound students but not to students in technical schools whose needs are quite different." Further, they felt that "the level of mastery of mathematics of graduates of the lower-academic track vocational programme is quite minimal. Theyargued that "this situation imposes a serious handicap on all graduates of this track who may choose to continue with their studies at a higher level." The academic discrimination against graduates of technical colleges in the Nigerian Education system tallies well with these remarks. In most admission exercises in Nigerian higher institutions, especially the universities, only successful graduates from secondary schools and teachers' colleges are considered as compared to their technical college

counterparts. This is usually based on assumed deficiency in academic standards of technical colleges' products. The researchers concluded with this remark:

> "But most of all, the study points to an urgent need to overhaul an obsolete secondary school mathematics programme in vocational schools including additional preparation for the secondary school teacher of mathematics to make him more aware of the uses of mathematics in the technology programmes."

This finding is directly related to some of the aspects of this study in which the secondary school mathematics syllabus is currently used in technical colleges in the country. It seems the new mathematics curriculum is obviously prepared to correct this anomalous setting.

Adams (1959:20) discussing vitalising mathematical teaching dwelt on the historical development of the subject. The continuous development of the subject, he felt, has been stimulated by scientific and technological requirements among other factors. He was of the opinion that: "for engineers, the subject is a means rather than an end." It seems reasonable and logical to argue that what is applicable to the engineer at the high level may directly be applicable to the craftsman at the low level. Under this teaching approach, he illustrated and described some of the wide range of visual aids used in mathematics teaching. The models were discussed under two-dimentions -

Dynamic and three-dimentions - Static and Dynamic. Among those models most appropriate to technical college situation are some plane table, determinant expander, piston displacement curve tracer, prisms cut into 3 pyramids, and volume common to 2 and 3 intersecting cylinders. The importance of models in teaching mathematics is not in doubt. In technical situations, models tend to reflect the real life situation and their assistance becomes even more apparent.

Rolf (1982:199) in a survey of the role of applications of mathematics in mathematics education in the Federal Republic of Germany, gave a general presentation of recent developments on the levels of the debate on mathematics education, of the curricula, textbooks, and of school practice and projects oriented towards applications. At the level of technical college, he wrote:

> In the school that provided vocational education belonging to Sekundarstufe II, application of mathematics, naturally have played an important role in preparing students for individual vocations and trades, although not in the sense of mathematics modelling. It is only recently that the attention of established mathematics educators has been caught by this type of school.

I am not sure whether this type of school has caught the attention of established mathematics educators in Nigeria since there is little to show in this direction. As

reported by Rolf (1982), attempts at reform are faced with difficult problems. In order to solve them, the author suggested that: "the present inefficiency of mathematics education in the vocational schools must be remedied, and the profound technological changes in the various work settings taken into account."

This report seems to coincide with the present efforts by the (NBTE) to redeem the situation of Nigerian technical colleges. Recently, the NBTE organised a national workshop on the "roles of technical colleges in the Nigerian Educational Scene in the late 1980's and beyond." Several papers on various sub-themes including curriculum proposals were discussed with an aim of evolving a national policy for the technical colleges. The German situation expressed above was confirmed by researchers like Straesser (1983:239), Blum (1983) and Knox (1983:237) who expressed the situation as follows:

> The search for an identification of the right way to solve a vocational problem, - the mathematization of the vocational situation, ... turnd out to be twice as difficult as the calculation itself. Apprentice often fail because they cannot correctly relate mathematics and the vocational situation, they have not learned to apply mathematics.

Straesser (1983) was of the opinion that "Mathematics in Technical and Vocational Education (TVE) cannot concentrate on the teaching of special mathematics topics but also has to provide the knowledge and skill of the mathematisation of a given or future vocational situation." To Lindsay (1987:241), " the problem for the teacher is how to maintain balance between the cultural aspects of mathematics and utiliterian content."

Knox (1983:237) conducted a study to find out what mathematics school leavers used in their first year at work based on various topics of the four operations with whole numbers, mental arithmetic, length, decimals, metrication, use of simple directive tables, areas and others. According to Knox (1983), this approach was used for the fact that: "the mathematical needs of school leavers are not found in the examination which are sat - this reflect the school syllabus." While the employers' selection tests in mathematics only reflected in part, what the firms thought it needed." The training officers were interviewed and the study used a four-point scale for assessing the importance of the topics in categorising their applicability. These were 'very important', 'useful', 'used occasionally' and not 'needed'. He was able to show which topics were important for craft

apprentices, and for commercial and sales workers. Some of the topics identified in this study will be included in the list of mathematical concepts, process and skills which will be assessed for their utility in the study of the various programmes.

A special correspondent (1960:20) who wrote on "the teaching of craft subjects - craft science", observed the difference between teaching science in a secondary school and on a craft course. He argued that "the craft teacher has to be more flexible: the science he teaches must be related in an active way to the works experience of his students in order to provide them with a motive for learning science." He went on to point out that every illustration the teachers use should come from the production environment of the trainees. He gave three reasons for the resistance to the postulated flexibility in the craft science syllabus as:

i. The teachers own knowledge of sciences is not always adequate for him to be selective over a wide range of topics.

ii. Finding and developing effective methods of relating science knowledge to craft situations takes a great deal of time, thought and imagination.

iii. The teacher may have an insufficiently varied industrial experience to draw on for topics to illustrate and clarify scientific principles.

The correspondent went further to advance the causes of such difficulties which are well known to education as follows:

> Industry is always ahead of education in its knowledge, acceptance, and application of technological advance. The result is that science is applied industrially in a way which is not always known to the teacher, so that the apprentice may be more up-to-date than the teacher in their stock of 'know-how', ... Again, the syllabus may not have been brought up-to-date so it would not have been made necessary for the teacher to consider new industrial developments and applications.

In the light of the above, he concluded that:

> There is a great teaching problem that has not yet been tackled seriously in education. It is that of the craft subjects teachers required to teach craft science without having had adequate fundamental education in science himself, and the other side of the coin-the science teacher required to teach craft science without having had craft training and experience.

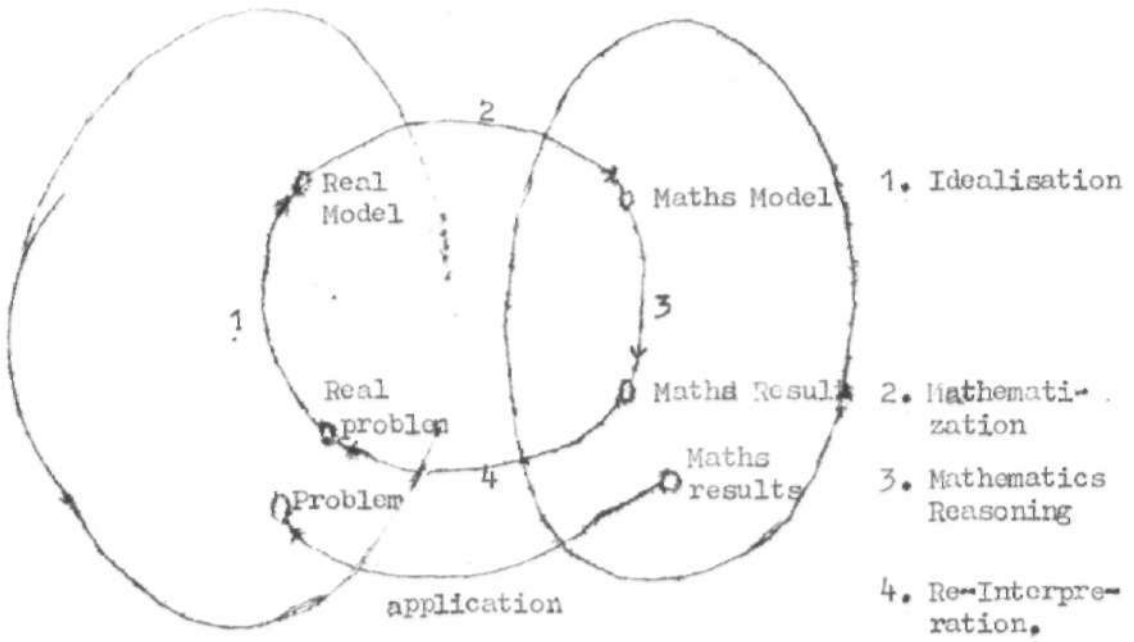
Kyelove and Oguntobi (1987b:6) made a similar observation in the teaching and learning of mathematics in technical colleges.

Badmus (1983:54) carried out a pre-implementation study of the teachers' perception of the new Junior Seconcary School Mathematics Curriculum. He used 126 mathematics teachers in 30 Seconcary Schools, 25 Grade Two Teachers' Colleges and 24 Comprehensive High Schools/ Technical Colleges. The sample was drawn from 5 states of Nigeria. He observed some disturbing results. Consequently, he expressed his feelings about the results as follows:

> The characterisation of teachers of Commercial/Technical Mathematics by very low score on relevance of content is very disturbing. Further research need be done on this to find out if it is the case that they feel many important topics for commercial or technical subjects have been left out or many topics not useful to their students have been included.

The same very low score was manifested on the teaching-learning strategies by the same Commercial/Technical Teachers. As for the need for further research demanded above, this current research effort may help provide some answers to the issues raised. On the teaching-learning strategies, Blum's (1983:245) model for the teaching and learning of mathematics in vocational and technical education will be useful in providing some explanation. The diagramatic representation of the model is shown in figure 2.1.

Figure 2.1: Bluns Mathematics Teaching-Learning Model In Technical Colleges.



In this model a student learns by a few examples to translate between mathematics and the real world, and especially that he or she learns to mathematize meaningful contents and learn general strategies for tackling real problems. The goals of this model are that mathematics education should-

i. contribute to better describing, better understanding and mastering present and not-too distant future problems from the student's vocational and everyday environment,

ii. try to attain so called formal aims, that is to advance cognitive strategies and intellectual techniques, such as mathematical reasoning and algorithmic thinking.

iii. contribute to equalising the opportunities of students by making possible further learning and advancement to higher education.

Implications for this interface between mathematics and employment is that, mathematics education works mostly by dealing with situations and problems coming from the corresponding vocational area and containing or leading to suitable mathematics topics. This cannot determine the curriculum, it provides only the methodology role as they show by example. This model could provide the basic knowledge or framework for examining the mathematics text-books to determine their suitability in the technical college context. Also the mathematics curriculum evaluation questionnaire (MCEQ) developed and validated by Badmus (1985) will be slightly modified and used to study the perception of the two groups involved in the study of mathematics in the technical college programmes.

2.7 Other Related Studies

Ademuga, et al (1987) conducted a study of the relationship between mathematics and Economics, as well as Mathematics and Geography. The study utilised the responses of students and lecturers of the Economics and Geography Departments of Ahmadu Bello University, Zaria. The study aimed at identifying the mathematics areas utilised in the study of these courses at the undergraduate level. The researchers were able to identify 26 mathematics concepts, processes and skills required for the study of economics and 21 for the study of Geography. The researchers were astonished with their findings when they expressed their feelings as follows:

> The researchers were delighted to find out such vast areas of geography that need mathematics. Infact, the topics cut across the whole syllabus, some students even after listing some areas of geography that need the use of mathematics went on to suggest that most topics in geography need mathematics.

In this study, equal efforts will be made to identify the mathematics topics commonly employed by technical students in their study of the trade programmes.

Fakuade (1977) on the aspect of mathematics as a service subject, enumerated the extensive use and role of mathematics in studies of environmental control, sciences:

Physics, chemistry and biology, social sciences, industries, technology and warfare. In engineering, he said that "mathematics are used both in its technical branches of research development and design; and also in manufacturing and commercial activities." He argued that "the better mathematician an engineer could have been, the bette r engineer he becomes and the more likely he is to make effective use of the mathematician." This statement is equally true of the craftsman- the more knowledgeable he is in mathematics, the more skillful will he be in the practice of his trade. Fakuade (1977) went further to identify certain engineering tasks that have recourses to the use of mathematics. He also identified one prominent responsibility of the mathematics teacher as that of presenting mathematics with an inter-disciplinary approach so that every professional group may benefit from the experience of others. In helping the teaching of the sciences, he identified the necessity to know the needs of the various science subjects through some communication means with the science teachers. Obviously, the necessity to know the needs of the technical trades and the establishment of some forms of communication with the technical teachers cannot be over-emphasised.

Ogunsulire (1977) discusses the role of mathematics in the sciences. He lamented over the generally negative attitude to mathematics irrespective of its practical values and the superstition attached to it. Other fields deeply penetrated by mathematical studies also discussed included Reasoning, Economics and Space travel. On the role of mathematics in the sciences, he observed that: "mathematics is often considered to be a handy tool of science - the basic instrument of science". Some mathematical giants and their contributions were acknowledged. Certain mathematical concepts and processes were identified with the scientific theories where they are commonly applied. Trignometric functions as applied to wave motions, sound, radio, light, water waves, and many other wave motions was cited as a typical example. This review, like the preceeding one, is aimed at identifying some science areas where mathematics concepts and skills could facilitate their understanding.

It is, however, Kalejaiye (1979) whose study provided the detail relationship between mathematics and physics. The findings from his study as reviewed by Badmus (1986) showed that the SSSMC of 1979 provided all the mathematics needed for the study of Physics then. Since that study by Kalejaiye (1979), there has been curricula reviews and

further developments both in Physics and Mathematics. Thus, Badmus (1986) carried out a study on the content relationship between physics and mathematics curricula for the Nigerian Senior Seconcary Schools.

Through literature review, Badmus (1986) developed a list of 36 mathematical concepts, processes and skills considered important to that study. Five graduate mathematics teachers with adequate physics background and five physics teachers with a sound background in mathematics were selected. The teachers were to examine and assess the utility of the selected mathematical concepts in physics curriculum for senior secondary schools (PCSSS). The selected teachers were provided with the PCSSS, the Nigerian Secondary Schools Science Project NSSSP) Physics Books I-III, the questionnaire and Form A (the mathematical list). They were also given copies of the JSSMC, SSSMC and FMCSSS, a questionnaire and Form B (as in Form A),

They were required to write 'E' (endorsed) against any of the 36 items in the questionnaire that they regarded as a pre-requisite for the understanding of physics content listed in a particular year; and write N (not endorsed) if it is not a pre-requisite. Form B with 5 columns was for the coordination between the time of utilization of

the selected mathematical concepts, processes and skills in PCSSS and the time when such items in JSSMC, SSSMC or FMCSSS are to be taught. The selected teachers were to use the 6 columns to indicate if the item on the list as needed in PCSSS was contained in the SSSMC or FMCSS and taught in SSSMC or FMCSSS before (b), at the same time (s) or after (a) they would be utilised in PCSSS in any year. From the results, the selected teachers were of the opinion that knowledge of 27 out of the 36 mathematical items were definitely needed for the mastery of the content of the PCSSS. Six of the items were found to be of little use while three items were of no use.

Further analysis showed that the overall correlation ratio between FMCSSS and PCSSS was 0.82 which was higher than that of SSSMC and PCSSS which was 0.62. The coordination ratio was closest in the first year and widest in the second year. The researcher concluded that the FMCSSS may be more beneficial to physics students than the SSSMC. The implications of this study extend beyond physical sciences. There is need for such studies to identify the mathematical needs of not only biological sciences or social sciences students but also technical studies. The procedure and data analysis techniques will be used in this current study to analyse the content

relationship of the mathematics and technical trades' curricula proposed to be used in technical colleges.

2.8 Summary And Conclusion

From the foregoing, the most essential issues involved in curriculum development have been identified and cited in the literature. Some curriculum models and steps involved in curriculum planning have been reviewed. The teachers central role in curriculum innovations and implementation are well discussed and highlighted, as well as the mode of curriculum control. The general context and programme activities in technical colleges are described and this is linked with the proposed change to be introduced. How these changes are geared towards meeting the objectives of technical education are dwelt upon.

Most of the mathematical tudies have a lot of meanings for this study. In some case, the studies and reports, particularly those of Fitzgerald (1975) and Badmus (1985, 1986) have given relevant recommendations and suggestions towards this present research effort. This may go a long way in assessing the teachers perception of the newly developed technical college mathematics curriculum. These studies have also provided the framework which this study will adopt in an attempt at illuminating the status of the new mathematics curriculum in technical colleges in Nigeria.

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the population and sample used in this study are described. Other measures discussed are the research design, the instruments, method of data collection and the technique of data analysis used. The presentation is given under the following sub-headings:

1. The population and sample,
2. The design of the study,
3. The Instrument/Instrumentation,
4. Validity and Reliability of Instruments,
5. Method of data collection, and
6. Techniques of data analysis.

3.2 The Population And Sample Of The Study

There are currently about 118 technical colleges in the country offering the 28 trade programmes. As earlier mentioned in section 2.4, this study focused on only the 22 technical (engineering) programmes excluding the Vocational (Business Education) ones. The findings of the Aina (1986) panel report on Technical Teacher production in Nigeria showed that there are 5,593 technical teachers in Nigeria. This number, as pointed out in the report, represented only 5.45% of the country's requirement

for technical teachers in both Secondary Schools and Technical Colleges. The NBTE'S (1984) report showed that there are 2,876 technical teachers teaching the various trade and academic programmes in these 118 technical colleges. Thus, the 2,876 teachers in these technical colleges constituted the total population of the study. By the letter of invitation from the NBTE (1988) to the Principals of Technical Colleges, the various heads of the Trades/Academic programmes or their representatives in each of the 118 technical colleges were requested to attend the series of National Seminars Organised by the Board. The Seminars were aimed at familiarizing the heads with the newly developed technical college curricula, who were in turn, expected to get their fellow teachers familiar with the materials. From the NBTE'S (1984; 89-174) report, 558 heads of technical programmes and 118 heads of mathematics departments inclusive or their representatives from the technical colleges were expected to attend the series of seminars. Table 3.1 below showed the number of technical colleges offering each of the 22 trade programmes. Mathematics being a compulsory course, is offered in all the technical colleges.

Consequently, there were two sub-groups that formed the population for this study:

i. The Mathematics Teachers teaching Mathematics in Technical Colleges. Sixty Mathematics teachers were intended to be used in this study but only fourty-five were available for the study. The reason for this short fall are explained under Section 3.6.

ii. The technical teachers in Technical Colleges teaching the various trades of specialization. Sixty were randomly selected from the participants at the NBTE's seminars and used in this study.

These two sub-groups were used to determine what they perceived as the mathematical training needs of the students as well as their own needs as teachers in the programmes. The technical teachers were randomly selected from the participants at the series of National Seminars Organised by the NBTE, Kaduna. The participants at the seminars were chosen because they were considered representative of all the technical colleges in the country. Besides, the choice of the NBTE seminars was also appropriate in order to save cost, time, due to proximity and above all uniformity of the seminar settings. It is pertinent to remark here that, the attendance at the seminars were far below the NBTE's expectation. There were about 180 technical teachers and below 30 mathematics teachers who attended the seminars.

Table 3.1: Table Showing The Number Of Technical Colleges Offering The Various Trade Programmes in Nigeria.

S/N.	Name Of Programme	No of Tech. Colleges offering the Prog.
1.	Agricultural Mechanization	9
2.	Motor Vehicle/Auto Mechanic	62
3.	Motor Vehicle Body work	4
4.	Auto Electrician	2
5.	Foundry	3
6.	Mechanical Engineering Craft	33
7.	Welding	21
8.	Fabrication/sheet metal work	16
9.	Glass Blowing/Manufacturing	1
10.	Instrument Mechanic	3
11.	Carpentry and Joinery	46
12.	Wood Machinning/Carving	2
13.	Block laying/Concreting	63
14.	Painting and Decoration	16
15.	Tropical Plumbing	15
16.	Architectural Drafting	2
17.	Furniture Craft	31
18.	Electrical Installation	69
19.	Radio and Television work	23
20.	Refrigeration/Air-conditioning	12
21.	Telecommunication	2
22.	Photographic Technology	1
23.	Mathematics	116

Source: NBTE (1984): Digest of statistics on Technical Education in Nigeria. 87-174.

The assessment and rating of the mathematics topics required for the understanding of the trades' content was done by 20 teachers. They comprised of five mathematics graduates and /or Higher Diploma in Mathematics Education teachers with adequate background in a technical trade and five technical teachers each from the three major trades' groups (Building, Electrical and Mechanical trades) with adequate background in mathematics. Adequate technical background in respect of the mathematics teachers entailed that, he must have attended a technical college and possessed at least the WAEC (TECH)/CGLI. (Intermediate) Certificate in one of the technical trade programmes. On the other hand, a technical teacher is assumed to have adequate background in mathematics, if he is a graduate in Technical Education. This is due to the fact that most degree programmes in technical education offer compulsory courses in mathematics at all the levels of the programme, and the mathematics contents are generally above or at least equivalent to the G.C.E. 'A' level mathematics. Such technical teachers were also teaching Science and calculations currently in their various trade programmes or mathematics. He too must have attended a Technical College.

3.3 The Research Design

In order to answer the research questions and test the hypotheses raised in Chapter one (1.6 and 1.7), it was necessary to establish a framework from which to proceed. Consequently, the following steps were adopted.

i. The Mathematics Curriculum Evaluation Questionnaire(MCEQ) developed by Badmus (1985) to study the perception of teachers for the Junior Secondary School Mathematics Curriculum (JSSMC) (pre-implementation) was adapted and used to study the teachers' perception of the new TCMC. Items that focus on the objectives of Secondary Education were modified to focus on the objectives of Technical Education as outlined in the NPE (1981). While the MCEQ constituted section II of the questionnaire, section I was used to help described the characteristics of the respondents. (Appendix B). Literature reviewed clearly acknowledged that individual perception do constitute a focus of study. This has, thus, justified perception as a transactional approach.

ii. Through literature search and review, a competency list of mathematics topics expected of craftsmen to have mastered and considered important to the study was developed.

iii. The new trade curricula were examined for the extent of utility of the selected mathematical items.

iv. The new TCMC was examined to see if the selected mathematics topics are contained in them.

3.4 The Instrument/Instrumentation

Two types of instruments were used for this study. They were:

(a) The questionnaire, and

(b) The list of Mathematics topics.

The Mathematics Curriculum Evaluation Questionnaire (MCEQ) used in the study was developed and validated by Badmus (1985) and used for a pre-implementation study of the teachers' perception of the JSSMC. The MCEQ is a 42 - item, 3 point likert type instrument containing six a priori scales designed to measure perception on six dimensions of a curricular entity. These were:

1. General objectives of teaching mathematics (in Technical College - Modified) in Nigeria.
2. Relevance of Instructional objectives.
3. Relevance of content of Instruction.
4. Balance and scope of content of Instruction.
5. Reasonability of organisational structure of content of instruction.

6. Feasibility and applicability of teaching and learning strategies.

Each of those six dimensions have seven items. The Badmus (1985) scoring procedure which followed from that of Harris (1973) was used; a score of +1 was assigned to the "Agree", 0 to the "undecided" and -1 to "Disagree" for each positively framed statement, while the scoring was reversed for negative items. Some items (five in number) of the questionnaire were modified in the sense that, those tending to reflect the goals and objectives of teaching mathematics in Secondary Education were modelled to reflect the objectives of technical education. The views and clarification of the author was sought on its usage and modification. The number of items as well as their positive and negative framing remained unaltered. The MCEQ formed Section II of the questionnaire used in the study. The Section I of the teachers' questionnaire contained demographic or personal information. Responses to this section were also used in answering two of the research questions raised in section 1.7. The information sought in Section I was used in describing the sample and aided in the statistical analysis. The responses to the MCEQ were used in testing hypotheses Ho_1, Ho_2, Ho_3, Ho_4 and Ho_5.

The list of mathematics topics were drawn from the literature on the basis of reviews of their usage in similar or other studies. The sources of the instrument were Fitzgerald (1976, 1979), Knox (1977), Berenson and Robinson (1983), Blum (1983), Straesser (1983), Matthews (1983) and Badmus (1986). When an item occured in any three of those sources except the last one, then it was selected. This preliminary list was subjected to scruting by two lecturers in Engineering Faculty who were teaching Mathematics in the Ahmadu Bello University, Zaria, Intermediate and Junior staff development programmes leading to the WAEC (TECH)/CGLI Parts I and II and four Technical Teachers in Technical Colleges who are also examiners for the WAEC (TECH)/CGLI part I and II. The views of lecturers in Mathematics Education and their recommendations were also considered. The assessment of the twenty selected teachers to the list of mathematics topics was used to test hypothesis Ho_6.

3.5 Validity And Reliability Of Instruments

The MCEQ was developed and validated, by Badmus (1985), with seventy-five secondary school teachers. The item analysis, as reported by Badmus (1985:42) showed that, "the correlation of each item with the scale to which it belongs ranges from 0.32 to 0.84, while the reliability coefficient, alpha, of the six scales

rangos between 0.50 and 0.71. The overall reliability coefficient, alpha, for the composite MCEQ was found to be 0.89, an estimate of its internal consistency". Inspite of the modification to reflect the goals and objectives of teaching mathematics in this type and level of technical education, the number, structure and composition of the items of the MCEQ were unaltered. Consequently, it was the researcher's belief that the validity and reliability of the instrument could not be significantly different from the original one.

The list of mathematics topics was validated by six experts. Two were lecturers in Engineering Faculty, Ahmadu Bello University, Zaria, who taught similar programmes for the A.B.U., Zaria I and J. Staff development programme, while the other four were graduate technical teachers in technical colleges who were also examiners for the WAEC (TECH)/CGLI parts I and II examinations. They were given the preliminary list with 53 items and were asked to mark (x) against those items they considered appropriate for the learning of the technical trade of their specialization. An item was finally selected if it was considered appropriate by at least four of the experts, or three experts and if it also appeared in the new technical college mathematics curriculum. The final list, then, has 50 items

(appendix C). On the basis of the literature reviewed and this scrutinizing the final competency list was considered to contain the valid and reliable mathematics topics necessary for the mastery of the trades' contents of the technical programmes.

3.6 Data Collection

The MCEQ was administered personally by the researcher to the Mathematics and technical teachers, with the assistance of some NBTE's staff, during the days of the National Seminars Organised by the NBTE to familiarize the teachers with the new curricula. These series of seminars took place between 2nd Feburary to 21st April, 1988 at the NBTE Conference Room, Kaduna. 145 questionnaires were served to the technical and Mathematics teachers. The respondents were expected to fill and submit the questionnaire within the two days of the seminar. However, those who could not respond to the questionnaire within the two days were given self-addressed stamp envelope for their return through the mail. Of the 72 questionnaires returned by the technical teachers, only 5 were through the mail. Twenty-five questionnaires were collected from the mathematics teachers at the Seminar since there were less than 30 who attended the mathematics group seminar. Participation in the study was entirely voluntary.

Though participation in the seminar was the major oriteria of becoming a respondent to the study, (for the case of t the mathematics teachers) the researcher had to visit some technical colleges in five states (Benue, Plateau, Bauchi, Borno and Kaduna) to make up for the expected number. Despite the second effort, only 45 questionnaires, in all, from the mathematics teachers were collected. Consequently, 60 questionnaires randomly selected from the 72 technical teachers and 45 of the mathematics teachers constituted the number of subjects (105) used in the study.

The materials and assessment forms (appendix D) for the twenty selected specialist teachers were administered to them by the researcher both at their various places of work and at the seminars. Two were staff of Ahmadu Bello University, Zaria, four at Government Technical College, Makurdi, one at Baptist High School, Jos, and two at College of Education, Katsina-Ala. The other eleven were participants at the NBTE's Seminars. The completed forms were collected back by hand or through the mail for those who required some time to respond to them.

3.7 Design For The Analysis Of Data

There were both descriptive and statistical analysis of the data collected. The information gathered on demographic items were tabulated using frequencies and

percentages. They were also used in describing the characteristics of the sample. They were also used in comparing the basic characteristics of the two groups of teachers. The 95% confidence interval, that is an alpha level of 0.05 was used in all statistical analyses in the entire study. To test the first hypothesis that:

Ho_1: There will be no difference in the mean perception of the teachers on the six curricular issues raised on the TCMC as measured by the MCEQ;

the two factor-mixed effects design, Glass and Stanley (1970:469) was applied. The ANOVA for this design was used to test the difference in the mean perception of the teachers (random factor) on the six curricular issues (fixed factor). This design as pointed out by Winer (1962:104-138) is also referred to as a single factor experiment having repeated measures. The strategy for analyzing a repeated measures design of this nature is illustrated in figure 3.1 below.

To test Ho: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6$

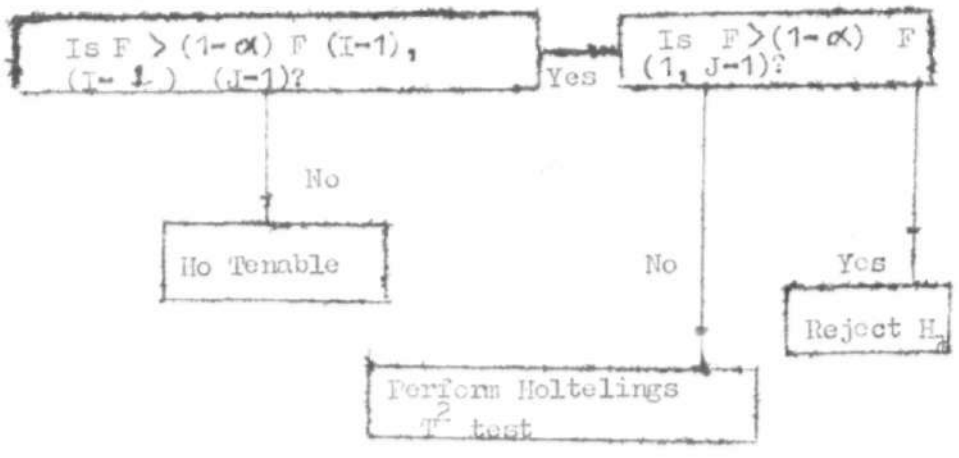


Figure 3.1: Schematic diagrams of the analysis of repeated measures design.

Source: Glass and Stanley (1970:471).

All the 105 subjects (both Mathematics and Technical Teachers) were used in this design.

To test the second hypothesis that:

Ho_2: There will be no significant difference between the perception of the two groups (MT and TT) of teachers on the six curricular issues raised on the new TCMC;

a two - factor fixed effects design with repeated measures on one factor (curricular issues) was applied. Table 3.2 below showed the outline of the design.

			Curricular Issues					
		Subjects	C_1	C_2	C_3	C_4	C_5	C_6
Teachers	MT	1 2 • • • 45						
	TT	1 2 • • • 60						

Table 3.2: A table showing the 2 factor - fixed effects or a 2x6 factorial design with repeated measures on one factor.

There were 45 observations per cell along the Mathematics Teachers (MT) column and 60 observations per cell along the Technical Teachers (TT) column. Winer (1962: 317) referred to this design as a two-factor experiment with repeated measures having unequal cell frequencies. The experiment was initially designed to have equal number of observations per cell, but due to the great short fall from the number of Mathematics Teachers who turned up for the NBTE's Mathematics group seminars, the data for this hypothesis was analysed using the method of unweighted

means analysis. The method was considered appropriate, since the loss of observations in the cells was essentially random (Winer, 1962:222).

Due to the logic and problems associated with analysis of non-orthorgonal designs, the technical teachers were selected in such a way as to produce an equal cell distribution as shown in table 3.3.

Table 3.3: A Table Showing The Cell Distribution Of Technical Teachers by Qualification And By Trade Type.

Trade Type	Qualification	Curricular Issues C_1	C_2	C_3	C_4	C_5	C_6
BD	PTT (10)						
	NPTT (10)						
EL	PTT (10)						
	NPTT (10)						
ME	PTT (10)						
	NPTT (10)						

PTT - Refers to professional technical teachers, i.e. Technical Teachers with a professional teaching qualification such as the B.Ed., N.C.E. (Tech) and T.T.C.

NPTT - Refers to non-professional Teachnical Teachers i.e. those technical teachers without any teaching qualifications such as holders of OND, HND, B. Eng., B.Sc., or F.T.C.

This design was used to test the third, fourth and firth(Ho_3, Ho_4, and Ho_5) hypotheses. This design is referred to as the three-factor experiment with repeated measures on one factor (curricular Issues) (Winer, 1962: 337-340). In fact there would be no interaction between the subject factor and the programme and qualification factors since it is nested under these factors(Winer; 1962; 338). The ANOVA was based on the fact that all the three factors: programme, qualification and curricular issues were fixed factors. When a null hypothesis was rejected and where necessary, the posteriori or post hoc pairwise comparison was done, using either the Turkey's (T-method) or Scheffe's (S-method) method.

The Cochran test was selected in the analysis of the responses of the selected twenty teachers. The choice of this test statistic was due to the non-parametric nature of the ratings of the twenty specialist teachers and since the response of the subjects was of two categories (endorsed or not endorsed). For each item, the higher number of endorsed(E) or not endorsed(N) among the teachers

in each group was taken as the group opinion. Besides, no carry-over effect was suspected from the response of the subjects. Consequently, this test was used in testing the difference among the teachers assessment of the utility of the selected mathematics topics in the trades programmes - that is testing the sixth hypothesis (Leach; 1978: 231-235).

The utility index - average group endorsement, for each item was also computed. This was used to classify the number of items considered necessary, little or of no use depending on the range of the index. Items with utility index of 1.0 were considered highly needed, those ranging from 0.5 to 0.9 were regarded as been of little use and those below 0.5 were regarded to be of no use. The TCMC was then examined on the basis of these topics to find out those topics omitted which were considered important or those included but assessed to be of no use.

Summary

In conclusion, the author had outlined the blue-print adopted in the study. These procedures had enabled t the researcher to gather all the necessary data which were analysed and presented in the next chapter. The analyses of such data gathered as outlined above, had helped to provide the answers to the research questions raised as well as test the hypotheses stated in chapter one of the study. In the next chapter, then the data and analyses carried out on the said data are presented.

Chapter 4

PRESENTATION AND ANALYSIS OF DATA

4.1 Introduction

In this chapter, as denoted by its heading, the data collected are presented and analysed. As earlier stated in the previous chapter, there were both descriptive and statistical analyses of the data collected. Answers to the research questions raised and testing of the research hypotheses stated in the null form were carried out in the course of data presentation and analyses. The data is presented and analysed under the following sub-headings.

1. Characteristics of the subjects.
2. Analysis of data on the teachers' perception.
3. Analysis of data on the assessment of the selected teachers.

4.2 Characteristics Of The Subjects.

The data presented under this section were derived from the response of the subjects to section I of the Questionnaire to the Technical and Mathematics Teachers (Appendix B). Two major research questions addressed under this section were:

1. What are the characteristics (such as basic educational background, basic qualification, the distribution of the teachers by sex and age) of the mathematics and technical teachers teaching in technical colleges?

2. What are the types and ages of the mathematics curricula currently in use in Nigerian technical colleges?

The subjects utilised in the study consisted of sixty technical teachers and forty-five mathematics teachers randomly selected from all the 118 technical colleges in Nigeria. Most of the selected teachers (85) were among those who participated in the series of seminares organised by the NBTE, Kaduna; while the other twenty mathematics teachers were randomly selected from eight technical colleges in five States (Bauchi, Benue, Borno, Kaduna and Plateau) of the country. The data were collected between 2nd February and 30th April 1988 at both the National seminars held at Kaduna and in the eight Technical Colleges.

Besides the one female technical teacher, all the other 59 technical teachers and the 45 mathematics teachers were males. Most (83.3%) of the technical teachers were over 30 years of age while the other 16.6% were below 30

years. On the other hand, most of the mathematics teachers' age range between 26 to 30 years. Table 4.1 provides the detailed summary of the teachers by sex and age.

Table 4.1: A Table Showing The Sex And Age Distribution Of The Teachers

		Tech. Teachers		Maths. Teachers	
		F	Percentage	F	Percentage
Sex	Male	59	98.3	45	100
	Female	1	1.7	-	-
	Total	60		45	
Age	20 yrs and below	1	1.7	3	6.7
	21 - 25 years	1	1.7	4	8.9
	26 - 30 years	8	13.3	22	48.9
	31 - 35 years	24	40	10	22.2
	36 years & above	26	43.3	6	13.3
	Total	60		45	

On fact seems obvious from the table: There are relatively very few female technical teachers teaching in technical colleges. The picture for mathematics is equally identical to that of the technical subjects. The age distribution of the teachers indicate that technical teachers are comparatively older than their mathematics counter-parts.

The response to items 4 and 5 pertaining to the types of post-primary institution attended and the basic qualifications obtained by the subjects are summarised in table 4.2.

Table 4.2: A Table Showing The Types Of Institutions Attended And The Basic Qualifications Obtained By The Subjects.

		Tech. Teachers		Maths Teachers	
		F	Percentage	F	Percentage
Type of School	Secondary School	5	8.3	24	53.3
	Comp. Sec. Sch.	1	1.7	3	6.7
	Craft/Tech. Sch.	24	40	6	13.3
	Trade Centre/ Tech. School	20	33.3	-	-
	Teachers Coll.	-	-	12	26.7
	Others: Teachers Coll. or Sec. Sch./Tech. Coll.	10	16.7	-	-
	Total	60		45	
Basic Qualification.	WASC	6	10	28	62.2
	G.C.E. 'O' Level	8	*	3	**
	WAEC(Tech)/ CGLI	54	90	6	13.3
	R.S.A.	-	-	-	-
	Grade II	-	-	11	24.5
	Others	-	-	-	-
	Total				

From the table, it is clear that 90% of the technical teachers (Craft/Tech. School, Trade Centre/Tech. School, and Teachers' College or Secondary School/Technical School) had attended a technical school while 10% had the Secondary School background. The qualifications pattern for the technical teachers followed closely from the types of institution attended with 90% and 10% having the WAEC (Tech)/CGLI and WASC qualifications respectively. However, 14.8% (8*) of the technical teachers with WAEC (TECH)/CGLI qualifications also had the G.C.E. 'O' level qualification.

On the other hand, 86.7% of mathematics teachers had attended either the Secondary School or the Teachers' College. Only 13.3% (6) of the mathematics teachers had the technical college background. Ironically, 3 out of these 6 mathematics teachers with the technical college background were not qualified mathematics teachers in the true sense of it. They had either the HND or B.Sc. (Enginneing) but not in Mathematics or Mathematics Education. The other 3 of the 6 mathematics teachers with the technical college background were among those who had the G.C.E. 'o' level together with their WAEC(Tech)/CGLI qualifications and proceeded to read mathematics at a higher institution rather than a technical subject.

Items 6 and 7 seek to find out the types and ages of Mathematics Curricula currently in use in the various technical colleges in the country. The responses were as presented in table 4.3.

Table 4.3: A Table Showing the Types Of Mathematics Curricula Being Used and Their Ages in The Technical Colleges as Indicated by The Respondents.

		Ages of Maths. Curricula				
		2 yrs and Below	3-5 Years	6-10 Years	Over 10 Years	Total
Type of Maths Curr.	WAEC/SC.	-	10	15	10	35
	GCE o' L.	1	7	4	28	40
	Grade II	-	-	-	-	0
	Teacher prepared	-	1	-	-	1
	SSS Maths Curr.	3	12	-	-	15
	Others (NBTE)	14	-	-	-	14
	Total	18	30	19	38	105

From the table 4.3, it seems clear that it is the G.C.E. O' Level mathematics curriculum representing 36.2% that is used in most technical colleges. It is most likely the G.C.E. O' level mathematics curriculum of the November/December Examinations meant for external

candidates, is used in these colleges. This is closely followed by the WAEC/SC Mathematics curriculum for Secondary Schools. 14.3% (15) of the technical colleges used the SSS Mathematics curriculum. These technical colleges might have been those who were using the WAEC/SC or the G.C.E. 'O' level ones. From the table, 47.6% of the Technical Colleges use the Mathematics Curricula prepared for Secondary Schools (SSSMC and WAEC/SC) in Nigeria. This could easily be explained by the disposition of the mathematics teachers who mostly had their basic education from secondary schools. It is worth noting that there is no technical college currently using the Grade II teachers' college mathematics curriculum even though there are mathematics teachers with their background from such colleges. One mathematics teachers uses a teacher prepared mathematics curriculum - probably his own. It is interesting to note that about 13.3 % of the teachers from technical colleges that responded to this questionnaire have already started using the new TCMC prepared by the NBTE. This set of teachers or schools represent what Rogers (1962) termed "the innovators".

The area of the various mathematics curricula also depicted an interesting pattern. It seems to tally with the age distribution of the establishment of the technical

colleges themselves. 71.4% (75) of the technical colleges are using either the WAEC/SC or GCE O' level mathematics curricula, this may represent the oldest generation of technical colleges in the country. It is also most likely that, those that have already adopted the new TCMC might belong to this same set of first generation technical colleges which were established pre-1970 or up-graded to technical college status about that time.

On the years of teaching experience of the teachers table 4.4 gives the distribution.

Table 4.4: A Table Showing The Years Of Teaching Experience Of The Teachers.

	Tech. Teachers		Maths. Teachers	
	F	Percentage	F	Percentage
2 years and Below	2	3.3	6	13.3
3 - 5 years	16	26.7	20	14.5
6 - 10 years	13	21.7	15	34.3
11 - 15 years	22	36.7	4	8.9
Above 16 years	7	11.6	-	-

From the table, it can be seen that 70% of the technical teachers had over 6 years of teaching experience while the other 30% had 5 or less years of experience in the teaching of their technical trades. For the mathematics

teachers, 57.8% had 5 or less years of experience while 42.2% had between 6 and 15 years of experience in the teaching of mathematics. It is observed that the technical teachers, comparatively had more years of teaching experience than their mathematics counter parts.

4.3 Analysis Of Data On The Teachers' Perception

The data presented and analysed under this section were derived from the responses of the mathematics and technical teachers to the MCEQ. The raw scores for each of the 105 subjects on each of the six curricular issues are given in appendix E. These six curricular issues were, thus, the dependent variables in this aspect of the study. The means and standard deviations for all the subjects were computed. These are shown in table 4.5 and Appendix F.

Table 4.5: Table Showing The Means And Standard Deviations Of The Teachers On the Six Curricular Issues Raised On The TCMC as Measured By The MCEQ.

	Curricular Issues (Treatment)	n=105 Mean (μ_i)	S.D
C_1	General Objectives of Teaching Mathematics in Technical Colleges.	5.43	1.62
C_2	Instructional Objectives	5.35	1.57
C_3	Relevance of content	5.19	1.74
C_4	Balance and scope of content	4.78	2.05
C_5	Organisational Structure of content	4.30	1.95
C_6	Teaching-learning strategies	2.22	1.74

To test the first hypothesis that:

Ho_1: There will be no significant difference in the mean perception (scores) of the teachers on the six curricular issues;

the two-way mixed-effect ANOVA (single factor experiments having repeated measures) was used to analyze this data. Symbolically,

$Ho_1: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6$.

The summary of the analysis (results) are presented in table 4.6.

At the 0.05 level of significance, the critical value of the F-ratio is $F._{95}(5, 520) = F._{95}(5,00) = 2.21$ which is far less than the computed F-ratio of 91.38. The experimental data has contradicted the null hypothesis.

Table 4.6: A Table For The Two-way Mixed - Effects ANOVA With n = 1 (Single Factor Repeated Measures Design).

Source Of Variation	df	SS	Ms	F
Between subjects (Teachers)	104	1069.76	10.29	
Within Subjects	525	1731.83	3.30	
Between Treatment (Curricular Issues)	5	810.00	162	91.38**
Residuals	520	921.83	1.77	
Total	629	2801.59		

** $F._{95}(5,520) = F._{95}(5,\infty) = 2.21$ and

** $F._{95}(1,5) = 6.61$, $P < 0.05$.

However, discussing the procedure for analysis of the repeated measures design, Glass and Stanley (1970: 470-471) warned that for the rejection of the null hypothesis to be valid when the computed value of F is compared with the critical value of $(1-\alpha)$ F (I-1), (I-1)(J-1), the correlations of all pairs of levels of

the fixed factor (curricular issues) across the levels of the random factors (teachers) must be the same. He further asserted that violation of this assumption work to increase the actual probability of type I error above the chosen α. He then suggested a contigent hypothesis testing procedure for use whenever heterogeneous correlation are suspected. Badmus (1985:45) suspected that inter correlations of the scales are heterogeneous on the MCEQ. The strategy suggested for analyzing a repeated measures design of this nature was illustrated diagramatically in section 3.7, Figure 3.1.

Consequenty, applying that procedure, we found that the computed F-ratio of 91.38 is greater than $F_{.95}(5,520)$ = 2.21. We then proceeded to compare the F-ratio = 91.38 with $F_{.95}(1,104)$ = 3.94. Again, the computed F-ratio is greater than $F_{.95}(1,104)$. The null hypothesis was then rejected and we concluded that, there is statistically a significant difference between the mean perception (scores) of the teachers on the six curricular issues of the TCMC as measured by the MCEQ.

A posteriori or Post hoc pairwise comparison was done using the Turkey's method (T-method) as outlined by Glass and Stanley (1970:383-393). For details, see Appendix F. The summary of the results are presented in table 4.7.

Table 4.7: A Table Showing Differences Among The Treatment (Scale) Means.

	U_1	U_2	U_3	U_4	U_5	U_6
U_1	-	0.45	1.36	3.68	6.40*	18.19*
U_2		-	0.91	3.23	5.95*	17.74*
U_3			-	0.79	5.04*	16.83*
U_4				-	2.72	14.51*
U_5					-	11.56*
U_6						-

*f_{95} (6,624) = 4.03

An inspection of the table indicated that eight pairwise comparisons exceed the critical value of 4.03 and were declared significant at the α = 0.05 confidence level. We can, thus, conclude that:

1. The overall perceptions of the teachers on the TCMC with respect to each of the first five curricular issues is higher than their perception on the TCMC with respect to the teaching-learning strategies.

2. The overall perceptions of the teachers on the TCMC with respect to the general objectives of teaching mathematics at the technical college level, instructional objectives, and relevance of content is higher than their perception on the TCMC with respect to the organisational structure of the content.

To test the second hypothesis that:

Ho_2: There is no significant difference in the mean perception (scores) of the two groups of teachers (MT and TT) on each of the six curricular issues raised on the TCMC as measured by the MCEQ;

a 2x6 factorial design with repeated measures and unequal cell frequencies was applied in analysing the data. The original plan of the study as pointed out in section 3.2 called for equal number of observations per cell but due to the sharp drop in the attendance at the mathematics group of the NBTE's series of seminars for the mathematics teachers teaching in the technical colleges. Consequently, it was not possible to obtain the expected number of subjects (60) to be used in the study. The researcher was able to get only fourty-five mathematics teachers. As suggested by Winer (1960:224-244, 304-307, 317-318),

the data to test this hypothesis was analysed using the method of unweighted means analysis having $\bar{n}_h$ (harmonic mean of the data) observations per cell. The cell data and cell means of the two groups (MT and TT) are presented in table 4.8 and 4.9 respectively.

Table 4.8: A Table Showing The Cell Data For The Two Groups Of Teachers Over The Scales

		Scales (Curricular Issues)					
		C_1	C_2	C_3	C_4	C_5	C_6
MT	$\sum x$	265	267	260	249	222	120
n=45	$\sum x^2$	1607	1631	1578	1457	1212	388
	SS_{ij}	46.44	46.80	75.78	79.2	116.	68
	$\sum x$	305	295	285	252	230	113
TT	$\sum x^2$	1759	1633	1561	1375	1128	447
n=50	SS_{ij}	208.58	182.59	207.25	316.6	246.33	234.18

Table 4.9: A Table Showing The Cell Means For The Two Groups (MT and TT) Of Teachers.

	Scales or Treatment (Curricular Issues)						
	C_1	C_2	C_3	C_4	C_5	C_6	Total
MT (T_1)	5.89	5.93	5.78	5.53	4.93	2.67	30.73
TT (T_2)	5.08	4.92	4.75	4.20	3.83	1.88	24.66
Total	10.97	10.85	10.53	9.73	8.76	4.55	55.39

For the computational formulae for the main effects, interactions and within cells variations, (see appendix F and numbers 4 to 10 of appendix G). The summary of analysis for this data is presented in table 4.10.

Table 4.10: A table Showing The Summary Of Analysis Of Variance For the 2x6 Factorial Design With Repeated Measures And Unequal Cell Frequencies

Source of Variation	SS	df	Ms	F
Between subjects	1069.76	104		
T (Teachers)	157.89	1	157.89	17.8*
Subjects within groups	911.87	103	8.85	
Within subjects	1828.55	93		
C (Curricular Issues)	764.25	5	152.85	11.92**
TC (Interaction)	0.1	5	0.02	0.00
Cx Subjects Within group	1064.2	93	12.82	

*F(1,103) = 3.98

**F(5,83(= 2.34

According to Winer (1960:307-318), the denominator of the F-ratio for the between - subjects effects is the mean-squared of the subjects within groups, whereas the denominator of the F-ratios for the within-subjects effects is the mean-square of the Cx subjects within groups. He further observed that, it is not unusual in this kind of plan to find the ratio of these two denominators to be as large as 10:1 . The critical value for the $F._{95}$ (5,83) = 2.34 which is grater than the observed F ratio = 0.00. The data tend to support the hypothesis of zero interaction. But when the critical value for the $F._{95}$ (5,83) = 2.34 is compared with the observed F-ratio for the treatment (curricular issues), the former was less than the latter, contradicting the null hypothesis of no significant difference between the curricular issues. Similarly, the critical value for the $F._{95}$ (1, 103) = 3.98 is less than the observed ratio of F = 17.8, which again contradicted the hypothesis: there will be no significant difference between the two types of teachers (MT and TT). Thus, Ho_2 is rejected and we conclude that, there is a significant difference between the mean perception of the two groups of teachers (MT and TT) on the six curricular issues raised on the TCMC as measured by the MCEQ.

It would have been of interest to find out how these two groups differ in term of the criterion variables (Curricular issues). This could have been done using the discriminant analysis. This is not done since the two groups do not necessary share the same professional domain (field of specialization). Nevertheless, a critical observation and inspection was done on the profiles of the mean perception of these two groups of teachers. This was done since the data had supported statistically that there is a significant difference in the perception of these two groups over the six curricular issues.

An observation and inspection of the profiles as shown in figure 4.1, depicted the mean scores of each of the two groups of teachers on the six curricular issues. The profiles showed that for all the six levels of the scales (Curricular issues), the means perception of the mathematics teachers are higher than the corresponding means perception of the technical teachers. Some of the possible reasons that could be attributed to this trend will be discussed in the next chapter.

To test the third, fourth and fifth hypotheses, i.e. to determine the differences (if any) of the technical teachers' perception between the professional and non-professional technical teachers involved in the three major

types of technical trades (Building, Electrical and Mechanical), on the six curricular issues, the 3x2x6 factorial design with repeated measures on one factor was used to analyse the data. sixty technical teachers, 20 each from the three major trade groups were used. In each of the trades' groups, there were 10 teachers each belonging to professional and non-professional cadres. The layout of the design was shown in table 3.3. According to Winer (1960:338), since the subject factor was nested under both the programme and qualification factors, there would be no interaction between these factors and the subject factor. The raw scores were already referred to in Appendix E. The summary data obtained from the scores are presented in table 4.11 (a, b, c and d).

Figure 4.1: Profiles of the Mean Perception of the two group of Teachers on the Six Curricular Issues.

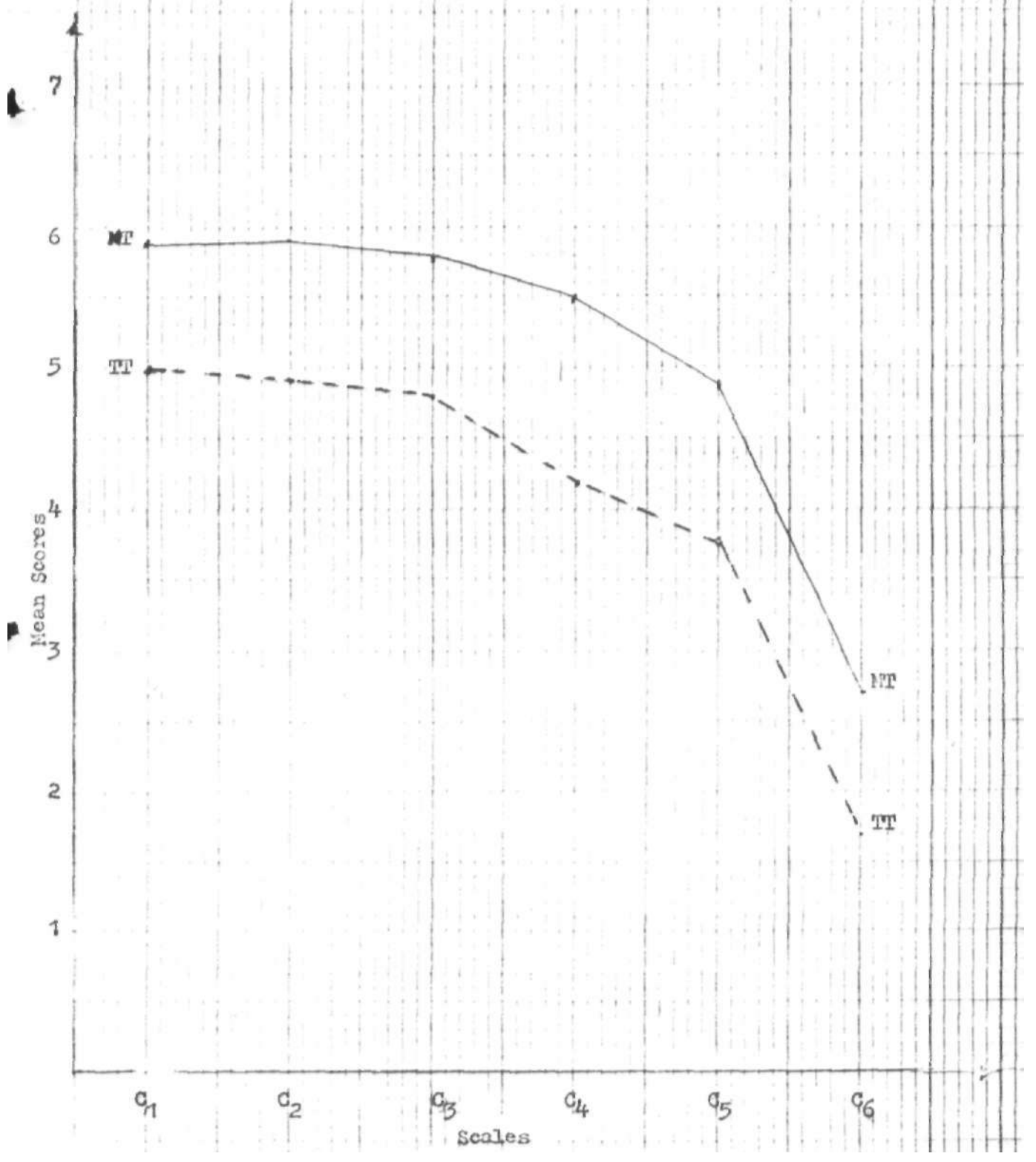


Table 4.11: Tables Showing The Summary Of Data Obtained For The 3x2x6 Factorial Design.

(a) Programme by Qualification by Treatment Summary Table.

		Treatment (Curricular Issues)						
		C_1	C_2	C_3	C_4	C_5	C_6	Total
BD	PTT	48	48	47	40	42	15	240
	NPTT	39	46	48	23	29	13	198
EL	PTT	49	43	48	41	38	14	233
	NPTT	60	55	44	50	34	07	250
ME	PTT	57	52	52	56	48	35	300
	NPTT	52	51	46	42	39	29	259
Total		303	295	285	252	230	113	1480

(b) Programme by Qualification Summary Table

	PTT	NPTT	Total
BD	240	198	438
EL	233	250	483
ME	300	259	559
Total	773	707	1480

(c) Programme by Curricular Issues Summary Table

		Scales (Curricular Issues.)						
		C_1	C_2	C_3	C_4	C_5	C_6	Total
Programme	BD	87	94	95	63	71	28	438
	EL	199	98	92	91	72	21	483
	ME	169	103	98	98	87	54	559
	Total	305	295	285	252	230	113	1480

(d) Qualification By Curricular Issues (Scales) Summary Table.

	Scales (Curricular Issues).						
	C_1	C_2	C_3	C_4	C_5	C_6	Total
PTT	154	143	147	137	128	64	773
NPTT	151	152	138	115	102	49	707
Total	305	295	285	252	230	113	1480

The hypothese tested in this design, stated in null form are as follows.

Ho_3: There will be no significant difference between the mean perceptions of the professional and non-professional technical teachers on the six curricular issues (scales) raised on the TCMC as measured by the MCEQ.

Ho_4: There will be no significant difference among the mean perceptions of the three major groups (BD, EL, ME) of technical teachers on the six curricular issues raised on the TCMC.

Ho_5: There will be no interaction of programme by qualification among the mean perceptions of the technical teachers on the six curricular issues raised by the MCEQ on the new TCMC.

The computational formulae used in analysing this data are stated under numbers 10 to 22 on the list of mathematical and statistical formulae (Appendix G). A summary of the analysis of variance are presented in Table 4.12.

Table 4.12: A Table Showing The Summary Of ANOVA For The 3x2x6 Factorial Design With Repeated Measures On One Factor.

Source of Variation	SS	DF	MS	F
Between Subjects	552.56	59	..	
Programme (A)	62.34	2	31.17	3.67*
Qualification (B)	12.10	1	12.10	1.42
Interaction (AB)	19.02	2	9.51	1.12
Subjects Within groups	459.1	54	8.50	
Within Subjects	1266	300		
Scales (C)	423.03	5	84.61	30.29**
AC (Interaction)	52.29	10	5.23	1.87**
BC (Interaction)	13.83	5	2.77	0.99
ABC (Interactions)	22.55	10	2.26	0.81
Cx Subjects within groups	754.3	270	2.79	

$^{**}F_{.95}\ (10,270) \approx F_{.95}\ (10,\infty) = 1.83$

$^{**}F_{.95}\ (5,270) = F_{.95}\ (5,\infty) = 2.21$

$^{*}F_{.95}\ (2,54) = 3.17$

$F_{.95}\ (1,54) = 4.02$

At the 0.05 level of confidence, the critical value of $F_{.95}\ (2,54) = 3.17$ is greater than the observed F ratio of the programme by qualification interaction of 1.12.

Thus, the hypothesis (Ho_5) of programme by qualification interaction is supported by the data. Similary, at the 0.05 level of confidence, the critical value of $F_{.95}$ (1,54) = 4.02 is greater than the observed F ratio of the qualification effect of 1.42. The data, thus, support the hypothesis (Ho_3) that, there is no significant difference between the mean perception of the professional and non-professional technical teachers on the six curricular issues raised on the TCMC.

On the other hand, the critical value of $F_{.95}$ (10,270) = 1.83 is less than the observed value of the F-ratio 1.87 for the programme by curricular issues interaction. This leads to the rejection of the Hypothesis (Ho_4) that the technical teachers major area of specialization will not significantly affect their perception on the six curricular issues.

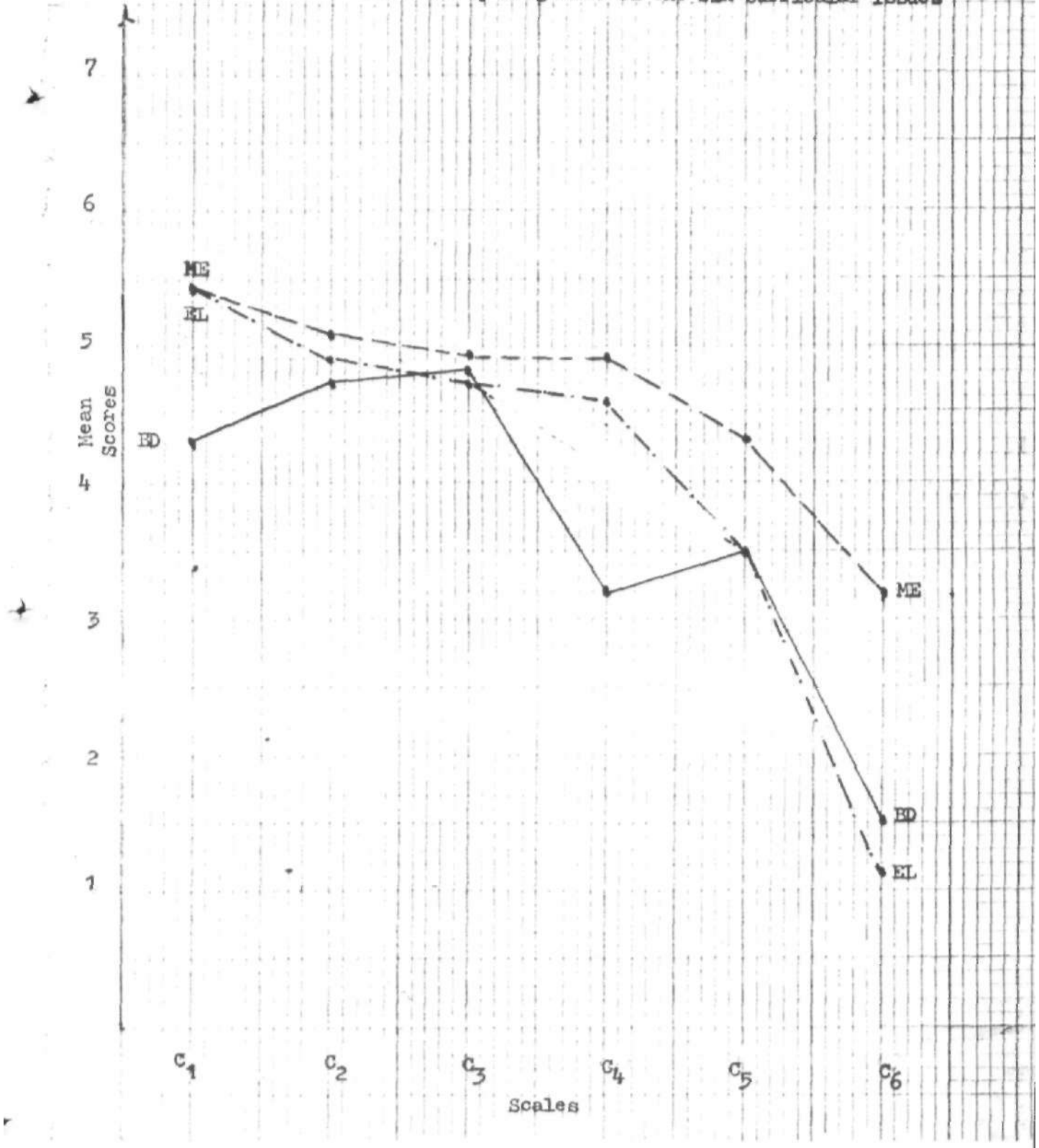
It is necessary to observed that the programme by qualification by curricular issues interaction is statistically insignificant since the critical value of $F_{.95}$ (10,270) = 1.83 is greater than the observed F ratio of 0.81. Since Ho_4 was rejected, it is necessary to do a critical inspection and observation of the means of the curricular issues by programmes. These are illustrated in table 4.13.

Table 4.15: A Table Showing The Mean Scores For The Programme Effect.

	Scales (Dependant Variables)					
Programme	C_1	C_2	C_3	C_4	C_5	C_6
BD (20)	4.35	4.7	4.75	3.15	3.55	1.4
EL (20)	5.45	4.9	4.6	4.55	3.6	1.05
ME (20)	5.45	4.15	4.9	4.9	4.35	3.2

From the observation and inspection of the profiles of the mean scores of the technical teachers by programme on the six curricular issues, as shown in figure 4.2, reveals that, variates C_1 and C_4 (General objectives and balance & scope of content) separate the Electrical and Mechanical trades' technical teachers from the Building trades' teachers. The Building trades, teachers have lower mean scores on these issues as compared to the other two groups. Secondly, variate C_6 (Teaching-learning strategies) separates the building and Electrical trades' teachers from the mechanical trades teachers with the mechanical teachers having the highest mean scores. Thus, the Building trades teachers are characterised by low scores on the general objectives of teaching mathematics, low scores on Balance and scope of content scale and low scores on the teaching-learning strategies. The Electrical trades'

Figure 4.2: Profiles of the Mean Scores of the Technical Teachers by Programme on the Six Curricular Issues



teachers are characterised by high scores on the general objectives of teaching mathematic scale and low score on the teaching-learning strategies. The mechanical trades' teachers were characterized by high scores on the general objectives of teaching mathematics, high scores on the Balance and scope of content scale and high scores on the teaching-learning strategies.

4.4 Analysis Of Data On The Assessment Of The Selected Teachers.

The analysis of the data under this section is based on the assessment of the twenty selected experts teachers: five from each of the three major trades' groups and Mathematics. As stated earlier in section 3.6, the selected teachers, who were all professionally qualified and with over five years of teaching experience were given copies of:

(a) The technical college mathematic curriculum.

(b) The NBTE's Curriculum of their trades of specialization if they did not have their own copy. 16 of the teachers had their own copies.

(c) A questionnaire, Form D containing the 50 Mathematics topics listed in Appendices C and D.

The other details of the instructions for their responses to the questionnaire are contained in Appendix C. The average responses of the five selected Mathematics teachers together with those of the other five from each of the three major trades' groups(Building, Electrical and Mechanical) were used to test the sixth null hypothesis Ho_6. The average responses of the teachers by area of specializations are summarised in table 4.14.

To test the sixth hypothesis that:

Ho_6: There will be no significant difference among the mathematics; Building, Electrical and Mechanical trades' teachers in their assessment of the utility of the selected mathematics topics in the mastery of the Technical trades' programmes.

The Cochran test was applied. The summary of the responses given in table 4.14 were used.

From the table 4.14

$$\sum B_i^2 = 8375$$

$$\sum L_i^2 = 714$$

$$\sum B_i = G = 184.$$

Table 4.14 The Average Responses of the Mathematics; Building, Electerical and Mechanical Trades' teachers on the Mathematics topics needed in the Mastery of the Content of the technical trades' curricula. Summary of the data from form D.

Group of Teachers K = 4								
Maths Topics	1	2	3	4	Ii	Ii^2	U	Availability of Topics in the TCMC
1.	E	E	E	E	4	16	1.0	X
2.	E	E	E	E	4	16	1.0	X
3.	E	E	E	E	4	16	1.0	X
4.	E	E	E	E	4	16	1.0	X
5.	E	E	E	E	4	16	1.0	X
6	E	E	E	E	4	16	1.0	X
7.	E	E	E	E	4	16	1.0	X
8.	E	E	E	E	4	16	1.0	X
9.	E	E	E	E	4	16	1.0	X
10.	E	E	E	E	4	16	1.0	X
11.	E	E	E	E	4	16	1.0	X
12	E	E	E	E	4	16	1.0	X
13	E	E	E	E	4	16	1.0	X
14	E	E	E	E	4	16	1.0	X
15	E	E	E	E	4	16	1.0	X
16	E	E	E	E	4	16	1.0	X

Group of Teachers K = 4								
Maths Topics	1	2	3	4	Li	Li^2	U	Availability of Topics in the TCMC
17	E	E	E	E	4	16	1.0	X
18	N	N	N	N	0	0	0.0	X
19	E	E	E	E	4	16	1.0	X
20	E	E	E	E	4	16	1.0	X
21	E	E	E	E	4	16	1.0	X
22	E	E	E	E	4	16	1.0	X
23	E	N	E	E	3	9	0.75	X
24	E	E	E	E	4	16	1.0	X
25	E	E	E	E	4	16	1.0	X
26	E	E	E	E	4	16	1.0	X
27	E	E	E	E	4	16	1.0	X
28	E	E	E	E	4	16	1.0	X
29	E	E	E	E	4	16	1.0	X
30	E	E	E	E	4	16	1.0	X
31	E	E	E	E	4	16	1.0	X
32	E	E	E	E	4	16	1.0	X
32	E	E	E	E	4	16	1.0	X
33	E	E	E	E	4	16	1.0	X
34	E	E	E	E	4	16	1.0	X
35	N	E	N	N	1	1	0.25	X
36	E	E	N	E	3	9	0.75	X
37	E	E	E	E	4	16	1.0	X

Group of Teachers K = 4								
Maths Topics	1	2	3	4	Li	Li^2	U	Availability of Topics in the TCMC.
38.	E	E	E	E	4	16	1.0	X
39	E	E	E	E	4	16	1.0	XX
40.	E	E	E	E	4	16	1.0	X
41.	E	E	E	E	4	16	1.0	X
42.	E	E	E	E	4	16	1.0	X
43.	E	N	E	E	3	9	0.75	XX
44.	E	N	E	E	3	9	0.75	X
45.	E	E	E	E	4	16	1.0	XX
46.	E	E	E	E	4	16	1.0	X
47.	E	E	E	N	3	9	0.75	X
48.	E	E	E	E	4	16	1.0	X
49	N	E	N	N	1	1	0.25	X
50	E	E	E	E	4	16	1.0	X
Bi	47	46	46	46				
Bi^2	2209	2116	2116	2116				

$\sum Bi = G = 185$

$\sum Li^2 = 719$

$\sum Bi^2 = 8466$

Thus, applying formula 23, appendix G,

$$Q = \frac{(K-I)(K\sum B_i^2 - G^2)}{KG - \sum L_i^2}$$

$$= \frac{3(4 \times 8466 - (185)^2)}{4 \times 185 - 719}$$

$$= 3 \times \frac{(-361)}{21}$$

$$= -51.67$$

Since nk = 200 which is greater than 30, the computed value of Q was compared with the tabulated Chi-square at k-1 = 3 degree of freedom which is 7.8 at the α = 0.05 level of confidence. Since this value of 7.8 is greater than the computed value of Q =-51.67, this led to the non-rejection of the null hypothesis. It is then concluded that; there is no significant difference among the selected mathematics; Building, Electrical and Mechanical trades, teachers' assessment of the utility of the selected mathematics topics in the mastery of the content of the technical trades curricula.

Since the results was not significant, there was no need to use the Mcnemar test and also do multiple comparison.

To answer the question: "To What extent will the views of the teachers on the utility of the selected

Mathematics topics depend on their areas' of specialization" the average number of E s for each item as shown in coloumn 8 of Table 4.14, indicated the extent of utility of that item for the mastery of the content of the trades' courses. Items with a utility index of 1.0 were considered to be highly needed; 0.5 to 0.9 were regarded to be of little use and below 0.5 were considered to be of no use.

The teachers' opinion on the 50 Mathematics topics based on this classification are summerised in table 4.15. This shows that in the opinion of the teachers, 42 items were considered highly needed for the mastery of Building, Electrical and Mechanical trades' curricula. While 5 items were considered to be of little use, three other items were basically considered to be of no use. Five of the items of little use are simultaneous equations (2 unknown), hand held calculators, simple Linear programming, introductory calculus, and Latitude and Longitude. The three items basically considered to be of no use are sets, Arithmetic progression and complex numbers which appear rejected in all the three major trades' areas.

Table 4.15: A Table Showing The Summary Rating of The Selected Teachers.

	Topics Highly Needed	Topics of Little Use	Topics of No Use
Range of Utility Index	1.0	0.5 -0.9	Below 0.5
Number of Items(Topics)	42	5	3

To answer the question: "Will the Mathematics Curriculum meets the needs of the trainees?", column 9 of table 4.14 (availability of the topics in the new TCMC) indicates those topics available(X) and those not available (XX) in the NBTE's technical college mathematics curriculum. An inspection of this column revealed two facts:

i. Two of the topics(flow diagrams for a scheme of work, and standards deviation) considered highly needed by the experts teachers are omitted from the TCMC.

ii. Three of the topics(Sets, Arithmetic progression and complex numbers) considered to be of no use by the assessors at this level of technical education are included to be taught in the technical college mathematics curriculum.

Nevertheless, since most of the topics(42) considered highly necessary for the mastery of the content of the various trades courses are included in the TCMC; it seems convincing that the curriculum will certainly meet the needs of the trainees and the teachers of these technical colleges.

Summary Of Findings.

Both the descriptive and statistical analysis of the data collected in this study were presented in this chapter. Based on these analyses, the following were the major findings.

Characteristics Of The Subjects

Based on the characteristics of the subjects, the following conclusions were deduced.

1. There are very few female technical teachers as compared to the males; teaching technical courses in technical colleges.

2. Most of the technical teachers teaching the various technical courses in technical colleges had the necessary technical background while most of their mathematics counterparts lack this technical background/orientation.

3. Prior to the development of the new FCNC, most technical colleges in Nigeria were using either the G.C.E. 'O' Level or WAEC/SC Mathematics Syllabuses prepared for Secondary Schools or Private candidates in the country.

4. Some of the technical colleges have already started using the NBTE's Mathematics Curriculum prepared for technical colleges in the country.

5. The Technical Teachers teaching their various trades' courses in technical colleges, were found to have had more years of teaching experience than the mathematics teachers teaching mathematics in these technical colleges.

The Teachers' Perception Of The TCMC.

The ANOVA (mixed effect, fixed effects and Factorial Design) with repeated measures was used to test the perception of the teachers on the TCMC based on the six dimensions of the curriculum entity as stated in the null hypotheses ($Ho_1 - Ho_5$). The following results were found.

6. The overall perception of the teachers (MT and TT) on the TCMC w.r.t. general objectives of teaching mathematics at this level of technical education, instructional objectives, relevance of content, Balance and scope of content and organisational structure of content were higher than their perception on the TCMC w.r.t. teaching-learning strategies.

7. The overall perceptions of the teachers on the TCMC w.r.t. the general objectives of teaching mathematics at the technical college level, instructional objectives and relevance of content were higher than their perceptions on the TCMC w.r.t. the organisational structure of the content.

8. The two groups of teachers (MT and TT) differ significantly in their perceptions on each of the six curricular issues raised on the TCMC with the MT having the higher mean perception on each of the issues.

9. Statistically, there was no significant difference between the professional and non-professional technical teachers in their perceptions on the six curricular issues raised on the TCMC.

10. The effect of the interaction of qualification by programme in the perception of the technical teachers on the TCMC was not significant.

11. The Building trades' teachers were characterised by low scores on the general objectives of teaching mathematics in technical colleges, low scores on the Balance and scope of content and low scores on the teaching-learning strategies.

12. The Electrical Trades' Teachers were characterised by high scores on the general objectives of mathematics scale, high scores on the Balance and Scope of content and low scores on the teaching-learning strategies.

13. The Mechanical Trades' teachers had high scores on the general objectives of teaching mathematics scale, high scores on the Balance and scope of content scale and high scores on the teaching-learning strategies.

Assessment By The Selected Experts Teachers.

The Cochran test was used to assess the teachers assessment of the selected Mathematics topics. This was used to test the null hypothesis Ho_6 . In this analysis, the following findings were obtained.

14. Assessment differences were not found among the selected teachers in their opinion on the utility of the selected mathematics topics needed in the mastery of the contents of the various technical trades' curricula.

15. 42 items on the list of Mathematics topics were found to be highly needed, 5 other topics were rated to be of little use and 3 topics to be of no use across all the trades' programmes.

16. Two topics: flow diagram for a scheme of work, and standard deviation, considered highly needed by the experts teachers were found to be omitted from TCMC.

17. Three topics: Sets, Arithmetic progressions and Complex numbers, considered to be of no use, in the mastery of the contents of the various trades, at this level of technical education were found to be included to be taught in the TCMC.

18. The content of the TCMC was found to be adequate in coverage and relevance in meeting the needs of the trainees, technical and mathematics teachers in these Colleges.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The problem addressed in this study, the purpose, justification and the delimitations of the study were all introduced in the first chapter. The review of related literature was done in chapter two. In Chapter three, the Methodology of the study was outlined. In the previous chapter, presentation and analysis of data, and interpretation of the results were reported.

In this final chapter, the followings are presented.

1. Summary, Conclusions and Findings.
2. Discussion.
3. Implications for Mathematics Education.
4. Recommendations for Future Research.

5.2 Summary, Conclusions and Findings

This section contains a summary of the purpose of the study, assumptions of the study, related literature, methodology and major findings.

This study had two major purposes. The first purpose was to evaluate the perceptions of the technical college teachers on the new TCMC recently developed by the NBTE in terms of six curricular issues. The study was, thus,

designed to provide a pre-implementation illuminative evaluation of the various perception held by the different participants involved in technical colleges towards the new TCMC. The second purpose was to undertake a detailed content analysis of the TCMC in order to assess whether it will meet the mathematical needs of the trainees, technical and mathematics teachers in technical colleges.

There were 7 questions with three focusing on the teachers' perception of the TCMC and two on the adequacy and usefulness of the contents of the TCMC. The other two questions were focused on the characteristics of the teachers. The questions were also concerned with the effects of qualification and programmes on the perception of the teachers. All the questions were stated in Section 1.7.

This study is based on the following two assumptions that: all those involved in technical education programmes are relevant sources of information with respect to the professional, industrial and academic needs for the improvement of technical colleges; and the instruments, questionnaires and other devices used for this study are appropriate to obtain the desired information.

This study has covered all the technical colleges in the country. The study was delimited to the recently developed TCMC, designed for the 3-years, post Junior Secondary Schools, Technical Colleges whose students

currently sit for the WAEC (Tech)/CGLI Parts I and II Examinations. Other NBTE's mathematics curricula of technical institutions offering programmes below and above this level are not examined in this study. Feed-back was sought from the mathematics and technical teachers in the Technical Colleges. The types of Mathematics curricula in use in technical colleges prior to the development of the TCMC will be identified.

Literature search revealed that there is little or no published work in technical education in general and mathematics curriculum studies in particular for the Nigerian Technical Education. However, most of the curriculum studies and mathematics education studies reviewed have a lot of meanings for this study, literature reviewed has confirmed the importance of the six identified curricular issues raised in the MCEQ. The MCEQ was developed by Badmus (1985) and used in a similar study for the evaluation of the teachers perception of the JSSMC. These issues are well reflected in most studies of curriculum design. Further literature review on studies in curriculum innovations has led to the identification of two crucial factors: the process and teacher factors. The teacher factor was identified by several investigators as the key factor in the operation and for the success of any curriculum. In fact, the choice

of the teachers as the central variable in the study of curriculum innovations had the support of most investigators. The effects of teachers' qualification and programmes on curriculum innovations were also cited by several researchers.

The few reports and studies in technical education had all indicated the little attention and priority accorded technical education as compared to the other types of education. Thus, this recent curricula development for technical colleges could only be viewed as an attempt to overhaul absurd programmes in these colleges. This had been the trend, even in some of the advanced countries, as indicated in several studies from these countries. The review of literature related to Mathematical studies in technical education had led to the identification of common mathematics topics employed by craftsmen in the study and practice of their various trades. Most of these investigators had tend to agree that the utility value of these mathematics topics differ in emphasis from one cluster of trades to another. However, the greatest problem identified by several investigators in this area is the background knowledge of the teachers who teach the general education subjects including mathematics. Most of the investigators seem to conclude that majority of these teachers' knowledge of mathematics is either in adequate or they lack the necessary technical background and orientation.

The data for this study was collected between 2nd February and 30th April 1988 at the series of seminars organised by the NBTE, Kaduna. Some few other data were collected in eight technical colleges in 5 States of Northern Nigeria. The seminars were meant to introduce and acquaint the technical and general education teachers with the new curricula recently developed by the Board to be introduced in technical colleges. The questionnaires were administered to the teachers during the days of the seminars. The subjects of the study were the mathematics and technical teachers teaching in technical colleges in Nigeria. Most of these teachers were the heads of departments of the various trades' programmes and mathematics in the technical colleges. The assessment of the selected mathematics topics was done by twenty selected experts teachers: five each from Mathematics, Building trades, Electrical trades and Mechanical trades. They were all qualified professional teachers with the necessary background and experience in Mathematics and one technical trade. The questionnaires and assessment materials for these selected teachers were administered to them at their various work places and at the seminars by the researcher.

Two types of instruments were used in this study. These were the MCEQ and another set of questionnaire together with a competency list of mathematics topics.

The MCEQ was developed and validated by Ba as (1985). It is a 42-items, 3 point Likert type of instrument containing six priori scales designed to measure perception on six dimensions of a curricular entity. Appendices A and B contained the TCMC and the MCEQ. The list of mathematics topics contained 50 items considered necessary for the ma mastery of the content of the various trades programmes. The details on this list and the questionnaire are contained in appendices C and D.

There were both descriptive and statistical procedures used in the analysis of the data collected. Appropriate statistics were selected to test the null hypotheses. The analyses included the followings: frequencies, percentages, means, standard deviations, ANOVA (mixed effects, fixed effects and factorial design) with repeated measures, chi-squared, Turkey's post hoc pairwise comparison method and inspection of profiles. The two-factors mixed effect analysis of variance was used to assess the difference in the mean perception of the teachers on the six curricular issues. To analyze the differences in the mean perption of the two groups of teachers (MT and TT) directly concerned with the teaching-learning and application aspects of mathematics in technical colleges, the two-factor fixed effects design was selected; while the ANOVA based on the $3x^2x6$ factorial design was used to

analyze the effects of programmes by qualification on the perception of the technical teachers on the TCMC as measured by the MCEQ. In order to analyze the responses of the selected teachers on the extent of utility of the mathematics topics in the mastery of the content of the technical trades, the Cochran test was used. All the hypotheses stated in null form and tested using the above designs were given in various sections of chapters three and four. The Turkey's post hoc pairwise comparison method and inspection of profiles were used to identify the sources of significant main effects and interactions. The α.05 alpha level of significance was the limit used in testing all the hypotheses in the study.

Findings And Conclusions

The descriptive and statistical analysis of the data collected in the study were presented in Chapter four. The following were the major findings.

Characteristics Of The Subjects

Based on the characteristics of the subjects, the following conclusions were deduced.

1. There are very few female technical teachers, as compared to the males, teaching technical courses in technical colleges. There was only one female technical teacher sampled in the study.

2. Most of the technical teachers teaching the various technical courses in technical colleges had the necessary technical background while most of their mathematics counterparts lack this technical background or orientation.

3. Prior to the development of the new TCMC, most technical colleges in Nigeria were using either the G.C.E. 'O' level or WAEC/Sc. Mathematics syllabuses prepared for secondary schools or private candidates in the country.

4. Some of the technical colleges have already started using the NBTE's mathematics curriculum prepared for the technical colleges in the country.

5. The technical teachers teaching the various trades' programmes in technical colleges were found to have had more years of teaching experience than the mathematics teachers teaching mathematics in these technical colleges.

The Teachers' Perception Of The TCMC.

The ANOVA (mixed effects, fixed effects and factorial design) with repeated measures was used to test the perception of the teachers on the TCMC based on the six dimensions of the curriculum entity as stated in the null hypotheses (Ho_1-Ho_5). The following results were found.

6. The overall perception of the teachers (MT and TT) on the TCMC w.r.t. the general objectives of teaching mathematics at this level of technical education, instructional objectives, relevance of content, balance and scope of content and organisational structure of content were higher than their perception on the TCMC w.r.t. the teaching-learning strategies. The teachers mean scores on the first five issues were 5.43, 5.35, 5.19, 4.78 and 4.30 while their mean score on the teaching-learning strategies was 2.22.

7. The overall perception of the teachers on the TCMC w.r.t. the general objectives of teaching mathematics at the technical college level, instructional objectives and relevance of content were higher than their perception on the TCMC w.r.t. the organisational structure of the content.

8. The two groups of teachers (MT and TT) differ significantly in their perceptions on each of the six curricular issues raised on the TCMC with the MT having the higher mean perception on each of the issues.

9. Statistically, there was no significant difference between the professional and non-professional technical teachers in their perceptions on the six curricular issues raised on the TCMC.

10. The effect of the interaction of qualification by programme in the perception of the technical teachers on the TCMC was not significant.

12. The programme effect, on the perception of the technical teachers on the six curricular issues of the TCMC, was found to be statistically significant. The Building trades teachers were characterised by low scores on the general objectives of teaching mathematics in technical colleges, low scores on the balance and scope of content and low scores on the teaching-learning strategies while the Electrical and Mechanical trades' teachers were characterised by high scores on the general objectives of mathematics scale, and high scores on the Balance and scope of content scale; the electrical trades teachers had low scores on the teaching-learning strategies while the mechanical trades' teachers had high scores on this scale.

Assessment By The Selected Experts Teachers.

The Cochran test was used to assess the teachers assessment of the selected mathematics topics. This was used to test the null hypothesis Ho_6.

In these analyses, the following findings were obtained.

12. Assessment differences were not found among the selected teachers in their opinion on the utility of the selected mathematics topics needed in the mastery of the contents of the various technical trades' curricula.

13. 42 items on the list of mathematics topics were found to be highly needed, 5 other topics were rated to be moderatedly needed and 3 topics to be of no use across all the trades' programmes.

14. Two topics: flow diagram for a scheme of work, and standard deviation, considered highly needed by the experts teachers were found to be omitted from the TCMC.

15. Three topics: sets, arithmetic progression and complex numbers, considered to be of no use, in the mastery of the contents of the various trades, at this level of technical education were found to be included to be taught in the TCMC.

16. The content of the TCMC was found to be adequate in coverage and relevance in meeting the needs of the trainees, technical and mathematics teachers in the technical colleges.

5.3 Discussions

The findings and conclusions reached in this study were presented in the previous section. A number of observations are made about the characteristics of the teachers, the perception of the teachers with respect to the curricular issues raised on the TCMC and on the assessment of some of the selected mathematics topics.

A major observation from the characteristics of the mathematics teachers concerns their basic educational background. Most of these mathematics teachers had their basic education in the Secondary Schools or teachers' Colleges. These two types of education do not provide the appropriate background for the effective teaching of mathematics in the technical colleges. This is due to the fact that most secondary and teacher education programmes

in the country do not provide adequate fundamental technical education for the teachers. Consequently, these teachers may find it difficult to develope effective methods of relating mathematical knowledge to craft situation which takes a great deal of time and imagination.

Prior to the development of this TCMC, it appears obvious that the teaching of mathematics in technical colleges had been in a confused state of affairs, given the multiple types of mathematics curricula in use, in the technical colleges across the country. It is then, not surprising to find that some technical colleges (13.3%) have already started using the NBTE's curricula, including that of mathematics, even though they were yet to be introduced to the colleges formally. However, several researchers, Miles (1964) and Rogers (1962) among others have cited these groups of early adoptors or innovators in several studies of curriculum innovations.

Similar to the present study, Badmus (1985), in the evaluation of the teachers perception on the JSSMC reported that differences were found in the perception of the teachers on the six curricular issues. In particular, the teaching-learning strategies scale was least favoured by the teachers. This result is equally manifested in this study. However, on a close inspection of the NBTE's Technical College Mathematics curriculum, it is noticed that unlike the

JSSMC, SSSMC and the Grade II Teacher Education Mathematics Curricula , the TCMC does not contain any guide on suggested teaching-learning activities. This is very disturbing given that most of the mathematics teachers in technical colleges do not themselves have the necessary technical background to relate mathematical concepts to technical situation. The situation seems more compounded when one observes that, the mathematics teachers will be teaching the trainees from the various technical programmes. The teachers' more favourable disposation to the general objectives of teaching mathematics to this type and level of education, and instructional objectives of teaching mathematics with respect to the NBTE's curricula could be attributed to two reasons. In the first instance, most teacher education programmes in the country, right from the Grade II to degree levels, have being placing high emphases on general objectives and instructional objectives of lesson planning. This might have provided the teachers with a good knowledge of these two dimensions. Secondly, these two dimensions were more highly emphasized at the NBTE's seminars as compared to the other issues. Aina (1988) paper to all the seminar groups, covered specifically these two dimensions.

That the two groups of teachers (*MT* and TT) differ in their perception on the TCMC is not surprising. The mathematics curriculum used in the study is the area of specialization of the mathematics teachers. Hence, the mathematics teachers' understanding on the TCMC would normally be expected to be higher than that of any group of teachers (technical inclusive). The difference could also be understood from the views held of mathematics by these two groups. The technical teachers are likely to be more selective in their choice of mathematics topics most appropriate to them. They may be more inclined towards the application of mathematics knowledge in their technical trades. The mathematics teachers, on the other hand, may be more interested in the general development of basic concepts and skills and have a fairly better overal knowledge of the subject.

That differences were not found between the professional and non-professional technical teachers in their perception on the TCMC may surprise some. Badmus (1985) found differences between the perception of professional and non-professional teachers. In the case of the technical teachers, industrial work experiences among others could have been responsible for such a setting. Among the technical teachers, industrial work experience is considered relevant and only next to educational qualifications.

The Building Trade's teachers were characterized by low scores on the general objectives of teaching mathematics at the technical colleges level and low scores on the balance and scope of content as compared to the other two groups of trades' teachers(Electrical and Mechanical). Based on this result, one could remark that there is a slightly higher premium placed upon the use of mathematics in the Electrical and Mechanical trades than the building ones. The large number of mathematics topics (42) considered highly needed across all the trades' programmes had indicated that, there are alot of common mathematics topics employed in all the trades programmes and a central mathematics curriculum could meet the needs of most of the trainees and technical teachers in these trades. Several investigators such as Fitzgerald(1979), Knox(1983), Matthews(1983, and Quading (1983) have reached the same conclusions. This is supported by the non assessment differences found among the selected teachers in their opinion on the utility values of the selected mathematics topics.

However, the non-inclusion of the topics: flow diagrams for a scheme of work and standard deviation, considered highly needed by the experts teachers only comfirmed the findings of several curricula investigators. There is hardly any curriculum designed with no omissions, weaknesses or oversight. This is even more apparent in fields with very little research work and a few number of experts such as technical education in general and technical mathematics in particular. With the recent call, from the public, for the introduction of Computer Education in Nigerian Secondary Schools, the inclusion of this topic (flow diagrams for scheme of work) which is computer oriented would have been quite justifiable and timely. The topic of standard deviation is so commonly applied in statistical qpplications today that one felt, its inclusion in the technical college mathematics curriculum would have been a non-negotiable issue.

Lastly, it is necessary to remark that, it appears difficult to take side on the three topics: sets, arithmetic progression and complex numbers; which were considered by the experts to be of no use but included in the new TCMC to be taught in the Technical Colleges. Though Curriculum reviews in Nigeria are more said than done; however, one can hope that some of these highlighted omissions, oversights and identified problem areas would be noted

and taken care of by the NBTE in its implementation of the TCMC and in its subsequent reviews.

5.4 Implications For Mathematics Education

In this study, it was found that most of the mathematics teachers in the technical colleges had their background education from either the Secondary Schools or Teachers' Colleges. It was also noted that, most of the Mathematics Teacher Education programmes in the country are geared towards producing mathematics teachers for primary schools, secondary schools and teachers colleges with no attention accorded to the technical colleges. It is then pertinent to argue that concerted attention should also be given to mathematics education programmes geared towards producing Mathematics Teachers for the Technical Colleges.

Consequently, the major implication here is for the mathematics teacher education. The importance and use of technical knowledge are being emphasized in terms of applications, especially in vocational and technical trades. Adequate staff developments are necessary for both preservice and inservice mathematics teachers. One could argue for the inclusion of mathematics teachers in the NBTE's sponsored programmes of curriculum studies for technical teachers offered at the department of Vocational and Technical Education, Ahmadu Bello University Zaria, and

other universities. Mathematics education programmes should include a course on teaching application of mathematics in technical and Engineering Fields.

5.5 Recommendations For Future Research

The following recommendations are based on the investigator's findings and conclusions in this study, already presented in this chapter.

1. It is recommended that similar studies be conducted in the NBTE's curricula of general education (academics) subjects such as English language, Integrated Physical Sciences, etc. to be used in Technical Colleges.

2. It is recommended that the same study be replicated, after the NBTE's curricula have been introduced in the Technical Colleges, after some time lapse of three years when the first batch of students using the curricula might have been at the verge of graduating from the technical colleges.

3. It is recommended that a survey study of female teachers in technical education and mathematics education be conducted to ascertain the true position of the number of such teachers in technical colleges.

4. It is recommended that a study by carried out using the mathematics teachers with the three different backgrounds from Secondary Education, Teachers Education and Technical Education to ascertain the effects of such backgrounds on their teaching effectiveness in technical colleges.

5. A detailed comparative study among the contents of the mathematics curricula for teachers colleges, Senior Secondary Schools and the Technical Colleges is recommended.

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APPENDIX A

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE

COURSE: MATHEMATICS

GOAL: This course is designed to provide the trainee with a sound knowledge of elementary mathematics to enhance his knowledge of mathematical concepts and their applications for solving trade problems and to prepare them for post-secondary technical education.

General Note:

1. Only students who did not have JSS Certificate or equivalent Certificate in Mathematics will be required to take Remedial Mathematics Module CMA 10.

2. To qualified for the award of the National Technical Certificate candidates must obtain pass grades in CMA II and CMA 12. For a full mathematics course candidate are to take CMA II - 14 which are pre-requisites for CMA 21 - 22 which should be taken by candidates enrolled in the Advanced National Technical Certificate.

MATHEMATICS

Code	Modules	Contact Hours
CMA 10	Remedial Mathematics	45
CMA II	Mathematics	30
CMA 12	Mathematics	30
CMA 13	Mathematics	30
CMA 14	Mathematics	30
CMA 21	Mathematics	45
CMA 22	Mathematics	45
	Total	255

COURSE: MATHEMATICS

MODULE: CMA II REMEDIAL MATHEMATICS

DURATION: 45 HOURS

GOAL: The module is aimed at providing the trainee with adequate mathematical background, a remedial course in foundation mathematics.

GENERAL OBJECTIVES:

On completion of this module, the trainee should be able to:

1. Count and carry out basic arithmetic operations in different bases.
2. Know S.I. Units of length, weight and time and convert from one unit to another.
3. Carry out arithmetic operations involving vulgar and decimal fractions.
4. Express numbers in standard forms to the required number of significant figures and decimal places.
5. Compare values by ratio and proportion.
6. Understand and apply the principles of percentage.
7. Solve problems involving simple interest.
8. Understand logarithms and apply logarithms, square and square root tables in solving mathematical prblems.
9. Understand the patterns of a sequence.
10. Understand the basic rules of logarithms.
11. Understand the laws of indices.
12. Understand mathematical statements using set notation.
13. Determine the perimeter and areas of simple geometric plane figures.

	General Objectives		Performance Objectives
		On completion of this course, the trainee should be able to:	
		Number Bases:	
1.0	Count and carry out basic arithmetic operation in different bases:	1.1	Count in different bases e.g. 2, 5, 8, 10 and 16.
		1.2	Convert from one base to another.
		1.3	Add and subtract in different bases (excluding fractions);
		1.4	Multiply and divide in different bases.
		S.I. Unit:	
2.0	Know S.I. Unit of length weight and be able to convert from one unit to another;	2.1	Explain the difference between S.I. and imperial units of linear measure;
		2.2	Convert millimeter(mm) to meter and meter to kilometer and vice-versa etc.
		2.3	Convert S.I. unit of weight, area and volume to imperial units vice-versa;
		2.4.	Solve problems involving time - hours, minutes and seconds.
		Fractions:	
3.0	Carry out arithmetic operation involving vulgar and decimal fractions.	3.1	Convert vulgar fractions to decimal fraction and vice-versa;
		3.2	Add, substract, multiply and divide in fractions and decimals to the required approximations.
		Numbers:	
4.0	Express numbers in standard forms to the required number of significant figures and decimal places:	4.1	Express number in standard forms e.g., $1120 = 1.12 \times 10^3$
		4.2	Round off numbers and give answer in the required number of significant figures.

General Objectives		Performance Objectives	
			Ratio & Proportion:
5.0	Compare values by ratio and proportion:	5.1	Explain ratio and proportion.
		5.2	Solve problems on direct and inverse ratios and proportions including representative factions.
			Percentages:
6.0	Understand and apply the principles of percentage.	6.1	Convert fraction and decimal to percentages and vice-versa.
		6.2	Calculate percentage change.
		6.3	Carry out calculation involving profit and loss
			Interest:
7.0	Solve problem involving simple interest.	7.1	Calculate principal rate; time, interest using appropriate formulae: $I = \frac{PRT}{100}$ Where I = Interest P = Principal R = Rate T = Time
			Logarithms:
8.0	Understand logarithms and be able to apply logarithmic, squares and square root tables to solve mathematical problmes.	8.1	Solve problems involving multiplication, division, powers and roots using log tables.
		8.2	Solve squares and square root problems using appropriate tables.

General Objectives		Performance Objectives
		Geometrical Progression:
9.0 Understand the patterns of a sequence.	9.1	Determine the n th term of a given sequence in a G.P.
	9.2	Solve harder problems in G.P.
10.0 Understand the basic rules of logarithms	10.1	Identify the basic rules of logarithms, i.e. $\log_{10} pq = \log 10\ p + \log 10\ q$ $\log 10\ p/q = \log 10p - \log 10_{q}$ $\log 10p^{n} = n\log 10\ p$
	10.2	Solve problems by applying the basic rules of logarithms e.g. $\log 10^{16} = \log_{10} 2^{4} = 4 \log_{10}$ $= 4 \times 0.3010$ $= 1.2040$
	10.3	Use logarithm tables in problems on compound interest, investments and annuities.
		Indices:
11.0 Understand the lows of indices	11.1	Indentify and state the laws of indices, i.e. $a^{p} \times a^{q} = a^{p+q}$ $a^{p} \div a^{q} = a^{p-q}$ $(a^{p})^{q} = a^{pq}$
	11.2	Explain the meaning of a^{o}, a^{-p} and a^{n} e.g. by considering $a^{p} \div a^{p}$, $a^{o} \div a^{p}$ and $a^{p} \times a^{p} = a^{1} = a$ where $2^{o} = 1$ etc.

General Objectives		Performance Objectives	
		11.3	Explain the relationship between indices and logarithms.
		11.4	Show with examples that indices and logarithms are inverse operations.
		11.5	Draw graph of $y = 10^x$ for $0 \leq x \leq 1$
		11.6	Use graph for multiplication and division.
			Sets:
12.0	Understand mathematical statments using set notation.	12.1	Explain what is a set, universal set, finite and infinite sets, empty sets.
		12.2	Interpret and use notations for union, intersection and compliment of sets and disjoint sets.
		12.3	Use venn diagram, a digramatic representation of set.
		12.4	Solve problems involving sets and classification using venn diagrams.
			Perimeter and Area of Geometrical Plane Figures:
13.0	Determine the perimeter and areas of simple geometric plane figures:	13.1	Differentiate between the following geometric plane figures, triangles, rectangles etc.
		13.2	Explain the meaning of:
			a) perimeter
			b) area of a plane figure.

General Objectives	Performance Objectives
	13.3 Calculate the perimeter of plane geometric figures: squares, rectangle, circle;
	13.4 Calculate area of:
	a) triangles b) rectangles c) rhombus d) parallelogram e) squares f) kite g) trapezium h) quadrilateral i) polygons j) circles

MODULE: CIA 12 MATHEMATICS

PRE-REQUISTIE: JSA MATHEMATICS

DURATION: 30 HOURS

GOAL: The module is designed to provide the trainee with an understanding of methods of constructing geometric figures as well as the use of algebra to solve mathematical problems.

GENERAL OBJECTIVES:

On completion of this module, the trainee should be able to:

1. Carry out arithmetic operations with algebraic symbols
2. Solve problems involving simple equations.
3. Understand the properties of lines and angles.
4. Understand the types and properties of triangles and polygons.
5. Carry out simple geometrical constructions using instruments.
6. Understand the theorem of pythagoras and be able to apply the concept in solving problems involving right angled triangles.
7. Calculate the surface area and volume of solid figures.

General Objectives		Performance Objectives	
		On completion of this module, the trainee should be able to:	
			Arithmetic Operation in Algebra:
1.0	Carry out arithmetic operation with algebraic symboles	1.1	Identify like and unlike terms.
		1.2	Add, subtract, multiply, and divide simple algebraic expressions.
		1.3	Introduce and remove brackets.
		1.4	Interpret literal statements into symbolic form.
		1.5	Solve problem in symbolic forms.
		1.6	Construct and evaluate formulae.
		1.7	Change the subject of any formulae.
			Simple Equation:
2.0	Solve problems involving simple equations.	2.1	Define simple equations.
		2.2	Solve s imple equations, e.g. $2x + 5 = 10x + 1$.
		2.3	Form equations from literal statements and solve them.
			Lines and Angles:
3.0	Understand the properties of lines and angles.	3.1	Define point, line, parallel lines, straight lines, curve perpendicular and horizontal lines.
		3.2	Identify the different types of angles: e.g. actute, obtuse; right angle; reflex angles; 30; 60; and 75 ; etc complimentary

General Objectives		Performance Objectives	
			and suplimentary; adjacent angles; vertically opposite angles alternate and corresponding angles.
			Triangles:
4.0	Understand the types and properties of triangles and polygons.	4.1	Identify the various parts of triangle.
		4.2	Identify the types of triangles and quadrilateral isoceles triangle right angle triangle scalene triangles; obtuse angled triangle rhombus; parallelograms; squares kite, etc.
		4.3	Apply the sum of the angles of a triangle/polygon to calculate any interior or exterior angle of a triangle/polygon.
		4.4	Identify types of polygons e.g. Pentagon, hexagon, heptagon, octagon decagon.
		4.5	Apply the sum of interior angles of a polygon of n sides to calculate any interior and exterior angle: using:-
			a. the formulae: $(2n = 4)$ right angle where n = number of sides of the polygon.
			b. the sum of the exterior angles of a polygon is 4 right angles.

General Objectives		Performance Objectives
		Construction of Angles and Lines:
5.0	Use instrument to carry out simple geometrical constructions.	5.1 Use protractors and ruler to draw angles of any side.
		5.2 Bisect straight lines and angles.
		5.3 Construct a line parallel or perpendicular to a given line.
		5.4 Construct an angle equal to a given angle e.g., 30°; 45°; 90°; 120°; etc.
		5.5 Divide a line segment into a given number of equal parts or into parts in a given ratio.
		5.6 Construct traingles and quadrilaterials using geometrical instruments.
		Theorem of Pythagoras:
6.0	Understand the theorem of pythagoras and be able to apply the concepts in solving problems involving triangles.	6.1 Explain the theorem of pythagoras.
		6.2 Apply the theorem of pythagoras, to find any side of a right angled triangle when two sides are given.
		Areas And Volumes of Solids:
7.0	Calculate the surface area and volume of solid figures.	7.1 Identify and draw various types of solid figures. e.g. cuboid, cylinder, cone, pyramids, prisms, hemisphere, and frustrum of cone and pyramid.
		7.2 Calculate surface areas of the figures listed in 7.1 above.

General Objectives	Performance Objectives
	7.3 Calculate the volumes of the figures listed in 7.1 above.
	7.4 Calculate the volumes of the containers and hollow solids, pipes, and hollow bricks.

MODULE: CMA 13 MATHEMATICS

PRE-REQUISITES: CMA 12

DURATION: 30 HOURS

GOAL: This module is aimed at providing the trainee with the knowledge of statistics, linear equations and graphical solutions to problems.

GENERAL OBJECTIVES:

On completion of this course, the trainee should be able to:

1. Represent statistical data in pictorial forms and charts
2. Calculate statistical averages.
3. Solve linear simultaneous equations in two unknowns.
4. Simplify simple algebraic expressions.
5. Know the factorization of algebraic expressions.
6. Plot graphs of simple algebraic expressions.
7. Understand the six trigonometric ratios and their application in solving problems.
8. Know distances along lines of latitudes and longitudes.
9. Understand the term "probability".

	General Objectives	Performance Objectives
		On completion of this module, the trainee should be able to:-
		Graphs and Charts:
1.0	Represent statistical data in pictorial forms and charts.	1.1 Represent given data in pictorial forms.
		1.2 Represent given data in Bar chart, histogram, graph and Pie chart.
		1.3 Interpret graphs, charts.
		Averages:
		2.1 Compile the frequency distribution with equal and unequal forms.
		2.2 Find the mode of given data.
		2.3 Calculate mean and median excluding group data.
		Linear Simultaneous Equation:
3.0	Solve linear simultaneous equations in two unknowns	3.1 Define simultaneous equation.
		3.2 Solve simple linear simultaneous equations.
		e.g.: $x + y = 8$ $2x + 3y = 8$
		i. by elimination ii. by substitution.
		3.3 Form and solve simultaneous equations from literal statements.

	General Objectives		Performance Objectives
			Evaluation of Algebraic Expressions:
4.0	Simplify simple algebraic expressions	4.1	Find the HCF and LCM of a given algebraic expression.
		4.2	Simplify algebraic fractions.
		4.3	Solve simple equations involving fractions.
			Factorization of Algebraic Expression:
5.0	Know the factorization of algebraic expressions.	5.1	Identify factorable expressions.
		5.2	Distinguish between non-quadratic and quadratic expressions.
		5.3	Factorize non-quadratic expression a) by introducing brackets b) by removing common factors.
		5.4	Recognise a) perfect squares e.g. $a^2 + 2ab + b^2 = (a+b)^2$. b) difference of two squares, e.g. $a^2 - b^2 = (a+b)(a-b)$. and apply them to factorize expressions.
		5.5	Factorize simple quadratic expression, e.g. $a^2 + 7a + 12 = (a+3)(a+4)$

General Objectives		Performance Objectives	
			Latitudes and Longitudes:
8.0	Know distances along lines of latitudes and longitudes:	8.1	Define latitude, and longitude as angles:
		8.2	Define longitudes and latitudes from geographical points of view;
		8.3	Relate definitions in 8.1 and 8.2 above;
		8.4	Determine distances along lines of latitudes and longitudes;
		8.5	Calculate distances on the surface of the earth.
			Probability:
9.0	Understand the term "Probability" and its application.	9.1	explain the term "probability", "event", mutually exclusive events, trials;
		9.2	Associate the probability of an event with an exact measure by theory;
		9.3	Determine the probability of an event with an exact measure by theory;
		9,4	Prove theoretical probability as a limiting value of experimental probability as the number of trials becomes large;
		9.5	Determine the probability of mutually exclusive events in the same population.
		9.6	Carry out addition and multiplication of probability for mutually exclusive events;
		9.7	Interpret 'and', 'or' in probability.

MODULE: CMA 14 MATHEMATICS

PRE-REQUISITE: CMA 13

DURATION: 30 HOURS

GOAL: The module is designed to provide the trainee with the knowledge of quadratic equations and properties of geometric figures.

GENERAL Objectives:

On completion of this module the trainee should be able to:

1. Solve and formulate quadratic equation.
2. Apply sine and consine rules to solve problems.
3. Know the conditions of congruency of triangles.
4. Know the properties of parallelograms and the application of these properties in solving problems involving quadrilaterals.

	General Objectives		Performance Objectives
			On completion of this module, the trainee should be able to:
			Quadratic Equations:
1.0	Solve and formulae quadratic equation.	1.1	Define quadratic equation.
		1.2	Solve quadratic equation by:
			i. factorization ii. completing the square iii. formulae
			i.e. $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

General Objectives		Performance Objectives	
		1.3	Form quadratic equation with given roots, e.g.
			$x = 3$
			$x = 3;\ (x - 3)\ (x - 4) = 0$
			$x^2 - 7x + 12 = 0$
		1.4	Form and solve quadratic equations from literal statements.
			Sine & Cosine Rules:
2.0	Apply sine rule and cosine rule to solve problems	2.1	State the sine and cosine rules
		2.2	Apply the rules to solve problems on triangles; e.g. bearing.
			Congruent Triangles:
3.0	State conditions of congruency of triangles and its application.	3.1	State the four condition for congruency i.e.
			i. side-side-side (SSS) ii. side-angle-side (SAS) iii. side-angle-angle (SAA) iv. right angle - hypotenuse - side (RHS)
		3.2	Apply the conditions in 3.1 to solve problems on triangles
			Properties of Parrallelogram:
4.0	Know the properties of parrallelograms and their application in solving problems involving quadrilaterals	4.1	State the properties of parallelogram, rhombus, and square by their sides, diagonals, sides etc.
		4.2	Solve problems involving the properties of parrallelogram

MODULE: CMA 15 MATHEMATICS

DURATION: 30 HOURS

PRE-REQUISITE: CMA 14

GOAL: The module is aimed at providing the trainee with knowledge of methods of calculating areas of reguhar and irregular figures.

GENERAL OBJECTIVES:

On completion of this module the trainee should be able to:

1. Solve problems involving areas of chords and areas of segments and sectors of a circle.
2. Solve problems involving areas of irregular figures.
3. Understand and use the mid-point and intercept theorems.
4. Understand the properties of similar triangles and their application in solving simple problems in geometry.
5. Identify and construct locus of a point in two dimensions.
6. Understand the proofs and applications of the theorems relating to the chords and tangents of a circle.

General Objectives		Performance Objectives
		On completion of this course, the trainee should be able to:
		Segments and Sectors of a Circle:
1.0 Solve problems involving areas of chords and areas of segments and sectors of a circle,	1.1	Distinguish between sector and segment.
	1.2	Calculate the length of an arc of a circle.
	1.3	Calculate the area of a sector.
	1.4	Calculate the area of segment, area of sector minus area of the triangles, e.g. rise and span of a segmental area.

	General Objectives		Performances Objectives
			Irregular Geometric Figures:
2.0	Solve problems involving areas of irregular figures.	2.1	Distinguish between regular and irregular figures.
		2.2	Calculate the area of irregular plane figures using mid-ordinate and trapezodial rules.
			Mid-point and Intercept theorems:
3.0	Understand and use the mid-point and intercept theorems.	3.1	Explain with annotated diagrams: a) the mid-point theorem b) the intercept theorem.
		3.2	Apply the theorems in item 3.1 to solve problems relating to proportional division of lines.
			Similar Triangles:
4.0	Understand the properties of similar triangles and their application in solving simple problems in geometry.	4.1	State the properties of similar triangles: i) all angles are equal ii) ratio of corresponding sides are equal.
		4.2	Apply the properties of similar triangles in 4.1 to solve simple problems on areas and volumes of similar plane geometrical shapes and solids respectively.
		4.3	Show that the bisector of an angle on a triangle divides the opposite side in the ratio of the side containing the angles.

General Objectives	Performances Objectives
	Loci:
5.0 Identify and construct locus of a point in two dimensions.	5.1 Define locus 5.2 Construct the locus of points which are:- i. at a given distance from a given point. ii. at a given distance from a given straight line. iii. equidistant from two given points. iv. at a given segment of a straight line subtends a given angle (constant angle locus.
	Chord and Tangent of a Circle:
6.0 Understand the proofs and application of the theorems relating to chords and tangents of a circle.	6.1 Explain with practical examples the following theorems associated with the chord a tangent of a circle; a. equal chord subtends equal angle at the circumference; b. the angle which an area subtends at the centre is twice that it subtends at the circumference; c. angles in the same segment are equal; d. angles of the opposite segment are supplementary in a cyclic quadrillateral;

General Objectives	Performances Objectives
	e. angles in a semi-circle is a right angle. f. an angle in a major segment is acute and angle in minor segment is obtuse; g. the rectangle contained by the segment of one is equal to the rectangle contained by the others (both internally and externally); h. a tangent is perpendicular to the radius of a circle. i. if two circles tough, the point of contact is on the line of centre; j. the direct and transverse common tangents to two circles are equal. 6.2 Apply the theorems in item 6.1 above to the construction of chain, belts, gears and sprockets etc.

COURSE: GMA 21 MATHEMATICS

DURATION: 45 HOURS

GOAL: The module is designed to provide the trainee with further knowledge in Mathematics to enable him understand and analyse scientific problems.

GENERAL OBJECTIVES:

On completion of this course, the trainee should be able to:

1. Solve simultaneous linear equations in three unknown variables.
2. Solve problems in arithmetic and geometric progression.
3. Find the expression for the expansion of higher powers of the binominal (for positive integers only) function.
4. Understand and apply the triangular and parallelogram laws of vectors.
5. Represent graphucally sine and consine functions.
6. Apply radian measures in calculations.
7. Solve problems involving straight lines in co-ordinate geometry.

	General Objectives	Performance Objectives
		On completion of this module, the trainee should be able to:-
		Simultaneous Linear Equation:
1.0	Solve simultaneous linear equations in three unknown variables	1.1 Identify problems involving linear equations in three unknown values.
		1.2 Solve the three unknown equations.
		1.3 Form and solve equations of three unknowns from literal statement.

	General Objectives		Performances Objectives
			Arithmetic and Geometric Progression:
2.0	Solve problems in arithmetic and geometric progressions	2.1	Distinguish between AP series and GP series.
		2.2	Use the AP and GP formula to find any term and the sum of the finite series.
			Binomials:
3.0	Find the expression for the expansion of higher powers of the binomial (for positive integers only) function.	3.1	Apply the pascal's triangle in the expansion of binomials.
		3.2	Apply the knowledge of binomial expansion to solve numerical problems.
			Vectors:
4.0	Understand and apply the triangular and parallelogram laws of vectors.	4.1	Distinguish between scalar and vector quantities.
		4.2	Represent vector quantities in two planes.
		4.3	Find the sum and differences of vectors.
		4.4	Resolve vectors.
		4.5	Apply vectors in the solution of relevant problems in forces, velocities, wind, aeronautics, etc.
			Graphs Sine & Cosine Functions:
5.0	Represent graphically sine and cosine functions.	5.1	Plot the graphs of sine θ and cosine θ for values between 0^0 and 360^0.
		5.2	Read off sine θ and cosine θ values from the graphs.
		5.3	Add and substract two or more graphs of sine θ and cosine θ.

	General Objectivew		Performance Objectives
			Measurement of Angles:
6.0	Apply radian measures in calculations	6.1	Distinguish between radian and degree measures of angles.
		6.2	Convert from radian to degree and vice-versa.
		6.3	Apply radian measures in the calculation of length of arc; areas of sectors and segments.
			Co-ordinate Geometry:
7.0	Solve problems involving straight lines in coordinate geometry.	7.1	Explain co-ordinates in a given plane.
		7.2	Locate points on the cartesian plane.
		7.3	Use cartesian coordinates to find: a) the distance between two points; b) the gradient of a line c) the equation of a line.
			Determine linear law from appropriate data.

MODULE: CMA 22 MATHEMATICS

DURATION: 45 HOURS

PRE-REQUISITE: CMA 21

GOAL: The module is aimed at equipping the trainee with the knowledge of calculus to enable him analyse simple engineering problems.

GENERAL OBJECTIVES:

On completion of this module, the trainee should be able to:

1. Perform arithmetic operations with complex numbers.
2. Differentiate simple algebraic functions.
3. Integrate simple algebraic functions.

General Objectives	Performance Objectives
	Complex Numbers:
1.0 Perform arithmetic operations with complex numbers.	1.1 Recognise that a complex number is a root of a quadratic equation whose discriminant is negative. i.e.: $b^2 - 4ac < 0$
	1.2 Represent complex number in a complex plane (argand diagram).
	1.3 Represent phasor in the form (at, ab).
	1.4 Carry out the four arithmetic operations (addition, subtraction, multiplication and division) on surds and complex numbers.

General Objectives		Performance Objectives	
			Differentiation of Algebraic Functions:
2.0	Differentiate simple algebraic functions	2.1	Find limits to simple algebraic functions.
		2.2	Draw the gradient of a curve at a point.
		2.3	Show that differentiation is the rate of change.
		2.4	Differentiate simple algebraic functions from first principles.
		2.5	Differentiate using the formula: $\frac{dy}{dx} = anx^{n-1}$ where $y = ax^n$ for integer n
		2.6	Apply differentiation to solve problems in maxima and minima, velocity, acceleration and rate of change.
			Integration of Algebraic Functions:
3.0	Integrate simple algebraic functions and apply them in solving problems involving areas under the curve.	3.1	Integrate difinite simple algebraic functions.
		3.2	Evaluate definite integrals of simple algebraic expressions.
		3.3	Apply integration in calculating the area under the curve.
		3.4	Use Simpson's rule to find area under the curve.

MATHEMATICS

LIST OF EQUIPMENT

Item of Equipment	No
Geometrical Instruments	
- Rule - Chalkboard	1
- Protractor-chalkboard	1
- Set square - Two pairs of 45 and 30°	2
- Pair of dividers-chalkboard	1
- Compasses-chalkboard	1
- Mathematical Set	30(may be purchased by students?
MODELS	
- Cupboard	1
- Prisms (different bases)	1
- Cylinder	1
- Cones	1
- Sphere	1
- Hemisphere	1
- Pyramid	1
- Frustrum of cone and pyramid	1
- Hollow cylinder and hemisphere	1
- Chain and tape	1
- Clinometer	1
MISCELLANEOUS	
- Dest calculators	30 (may be purchased by students).

APPENDIX B

QUESTIONNAIRE FOR MATHEMATICS AND TECHNICAL TRADE TEACHERS IN TECHNICAL COLLEGES

The Respondent,

This study aims at evaluating the teachers' perception of the New Technical Colleges Mathematics Curriculum recently developed by the National Board for Technical Education (NTBE) Kaduna.

Could you please go through the attached mathematic curriculum in detaisl before completing Section II of the questionnaire. You are not being evaluated as an individual. This is why your name is not needed. Thus, feel free to respond objectively. Your responses will be treated confidentially.

Thanks for your co-operation and contribution for the improvement of technical education, which I earnestly solicit.

KYELEVE, J.I. (Researcher)
Department of Education,
Mathematics Education Section,
Ahmadu Bello University,
Zaria.

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KYELEVE, J.I. (Researcher)
Department of Education,
Mathematics Education Section,
Ahmadu Bello University,
Zaria.

PART A: Introduction and General Information.

The objectives and aims of technical education, irrespective of the level it is provided, are outlined in the National Policy on Education (NPE) Section 6, Subsection 49 as follows:

(a) to provide trained manpower in applied science, technology and commerce, particularly at sub-professional grades.

(b) to provide the technical knowledge and vocat ional skilss necessary for agricultural, industrial, commercial and economic development,

(c) to provide people who can apply scientific knowledge to the improvement and solution of environmental problems for the use and convenience of man,

(d) to provide an introduction to professional studies in engineering and other technologies,

(e) to give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and self-reliant and,

(f) to enable our young men and women to have an intelligent understanding of the increasing complexity of technology.

Consequently, technical/vocational institutions in Nigeria in general are expected to play the following three roles. They should provide:

i. vocational courses intended to meet the occupational interests and career needs of the individual

ii. manpower training programme intended to meet social and economic policy goals of government, and,

iii. industrial training programmes intended to meet the skill needs of employers.

It is against this background that the role of the developed mathematics curriculum should be assessed in assisting to attain the above stated goals and objectives.

This mathematics curriculum is developed along with other curricula materials. They include Integrated Physical Sciences, English Language, Social Studies, Technical Drawing, Trade Practicals and Trade Theory. These subjects will be singly examined for the award of the National Technical Certificate (NTC) and the Advanced National Technical Certificate (ANTC) by the National Board for Technical Education. These two programmes, when eventually introduced, are intended to replace the current ·LEC (TECH)/City and Guilds Parts I and II, as well as the Federal Craft Certificate Examinations in the various trade programmes. These programmes, it is expected, are to be introduced in technical colleges from the 1989 academic year.

SECTION 1

This Section is to help the researcher to describe the respondents to this questionnaire. Please, tick or fill where appropriate.

1. Sex: Male:_____ Female:_____

2. Age: 20 and below: _____

21 to 25 years: _____

26 to 30 years: _____

31 to 35 years: _____

36 and above: _____

3. Please, indicate the Basic institution you have attended.

Secondary School _____

Comprehensive Secondary School _____

Craft School/Technical College _____

Trade Centre/Technical College _____

Teachers' College _____

Others (Specify) _____

4. Please, check ( ) your Basic Qualification(s)

WASC/GCE 'O' Level _____

WAEC (TECH)/City and Guilds _____

R.S.A . _____

Grade II _____

Others (Specify) _____

5. Please, check ( ) your highest qualification(s)

WAEE(TECH)/City and Guilds Parts I and II _____

Technician II/OND _____

N.C.E. _____

F.T.C./HND _____

B.Sc/B.Eng. _____

B.Ed/B.Sc.(Ed.) _____

B.Sc/B.Eng. and PGDE or T.T.C. _____

M.Sc/M.Eng. _____

M.Sc.(Ed)/M.Ed. _____

Others (Specify) _____

6. What type of mathematics syllabus/curriculum does your technical college currently use?

WAEC/Sc. _____

G.C.E. 'O' Level _____

Grade II T.C. _____

Teacher Prepared _____

Senior Secondary School Maths Curr. _____

Others (Specify) _____

7. Indicate for how long the mathematics syllabus in item 6 above has been in use in your college?

2 years and below _____

3 to 5 years _____

6 to 10 years _____

Over 10 years _____

8. Indicate the range of your teaching experience.

2 years and below _____

3 to 5 years _____

6 to 10 years _____

11 to 15 years _____

Above 15 years _____

9. Please, indicate ( ) the course(s) you teach in the technical college programmes

Mathematics _____

Mechanical Trades (Specify) _____

Electrical Trades (Specify) _____

Bulding Trades (Specify) _____

Others (Specify) _____

10. Which of the specialization in item 9 above is your major area?

Mathematics _____

Mechanical Trades (Specify) _____

Electrical Trades (Specify) _____

Building Trades (Specify) _____

Others (Specify) _____

SECTION II

Having gone through the new Technical Colleges Mathematics Curriculum, kindly complete this section of the questionnaire.

Based on your opinion and assessment of this mathematics curriculum as developed by the National Board for Technical Education (NBTE), please tick the appropriate column, A for Agree, U for Undecided and D for Disagree. All the items refer to the same mathematics curriculum.

Please choose only one option that best represents your opinion in each case.

MATHEMATICS CURRICULUM EVALUATION QUESTIONNAIRE (MCEQ)

Instruction:- Tick the appropriate column.

	Items	A	U	D
1.	The Curriculum can generate interests of the learner in Mathematics and provide them foundation for effective living in this age of science and technology;			
2.	The Curriculum cannot develop computational skills of the learners and provide them with essential concepts of spatial relationships;			
3.	The Curriculum cannot develop the ability of the learners to recognise problems and solve them with appropriate mathematical knowledge;			

Items	A	U	D
4. The Curriculum provides the learners with necessary mathematical knowledge for further education in various disciplines or trades;			
5. The Curriculum can develop precise, logical and abstract thinking in the learners;			
6. The Curriculum can stimulate and encourage creativity of learners in school and later life;			
7. The Curriculum cannot foster learners' desire and ability to be accurate to a degree relevant to the given problem;			
8. The contents are irrelevant to current thinking in mathematics education at this level of education;			
9. The contents are relevant to corresponding instructional objectives;			
10. The contents are relevant to the needs and interests of the learners;			
11. Contents are psychologically relevant because it conforms with the principles of learning and motivation;			
12. The contents are levevant to learners' experience and environment;			
13. The contents are not suitable for the stage of mental development of the learners;			
14. The contents are relevant more to the needs of bright learners (elitist) rather than the needs of most learners (non-elitiest);			

Items	A	U	D
15. Instructional objectives are clearly stated;			
16. The instructional objectives are reasonably attainable by most of the learners now known to be in this level;			
17. The instructional objectives are not related to general objectives of teaching mathematics at this level as stated in Part A above;			
18. The instructional objectives are appropriate for the learners at this particular level of education and stage of mental development;			
19. Instructional objectives are not likely to contribute cumulatively to the general objectives of (Technical College) mathematics teaching;			
20. The instructional objectives are not important enough to encourage and improve learning in various applicable areas like Science, Technology and Vocational areas;			
21. The instructional objectives are not important enough to encourage further learning in mathematics at the next level of Technical Education;			
22. Emphasis on computational skills is inappropriate;			
23. Emphasis on concepts and principles are appropriate;			
24. Emphasis on suitable, precise Mathematical language is appropriate;			
25. Topics are sequenced from the known to unknown (hierarchially);			

	Items	A	U	D
26.	The strategies are not flexible enough to accommodate a variety of methods;			
27.	The strategies are feasible with respect to time generally alloted to mathematics in (Technical) School;			
28.	The sequencing will not help to maximize learning;			
29.	Topics are not inter-related;			
30.	Coverage of Number and Numeration is appropriate;			
31.	Coverage of Geometry and measuration is inappropriate;			
32.	Coverage of Everyday Statistics is appropriate;			
33.	Topics are sequenced from the part to the whole (dovetailing);			
34.	Topics are not sequenced from the easy to the difficult;			
35.	The suggested activities will attract and motivate the learners;			
36.	Majority of the serving teachers will required inservice training before they can efficiently and effectively use the strategies;			
37.	Coverage of Algebraric processes is inappropriate;			
38.	Sequencing is incongruent to the readiness and experiences of the learners at this stage of development;			
39.	The activities are not suitable for general intellectual level of the learners;			

	Items	A	U	D
40.	Vital links are established with trade courses where Mathematics serves as a tool;			
41.	Adequate guides are not provided for teachers;			
42.	Guided discovery approach will not be practicable for lack of teaching materials and/or time.			

APPENDIX C

QUESTIONNAIRE FOR EXPERTS ASSESSORS/RATERS

Dear Respondent,

This study aims at analysing the content of the new mathematics curriculum for Technical Colleges recently developed by the National Board for Technical Education (NBTE), Kaduna.

The following materials are included here to help you in your response to this styd.

(a) The new Technical College Mathematical Curriculum
(b) The New Curriculum of your trade of specialisation
(c) A list and Form D containing the fifty mathematics concepts, processes and skills listed in table 1.

Could you please, examine the topic and their corresponding objectives, instructional objectives and the specified practical activities contained in (b) and identify which of the mathematics concepts, processes and skills listed in (c) that will be needed by the trainees for understanding the trade theory and practical work presented in (b).

Please write E (endorsed) against any of the 50 mathematical items if you regard them as pre-requisite for the understanding of the content of the trade programmes as specified in modules of (b). If an item is not a pre-requisite, please write N (not endorsed) against it.

Thanks for your cooperation and contribution which I earnestly solicit.

Yours,

Kyelevo, J.I. (Researcher)
Department of Education,
Mathematics Education Section
Ahmadu Bello University, Zaria.

TABLE 1

List of Mathematics Concepts, Processes And Skills needed For The Mastery of The Content Of The Technical College Programmes.

1. The Four Basic Operation.
2. Order of Arithmetical Operation.
3. Fractions (Operation with Vurgal/Decimal).
4. Metric System.
5. Measurement (Lengths, Diameters, Weights, Angles, etc).
6. Positive and Negative Numbers.
7. Drawing neat but accurate Sketches with or without instruments.
8. Drawing to Scales.
9. Understanding and Reading dimensions off scale drawings.
10. Approximations (Limits)
11. Algebraic Processes.
12. Standard Form.
13. Angles.
14. Parallel and Perpendicular Lines.
15. Plane shapes (Properties and Areas).
16. Solid shapes (properties, surface areas and Volumes).
17. Number Bases.
18. Sets (Disjoints and 1-1 Correspondence).
19. Organisation of Calculations on papers (neatness, accuracy and checking).
20. Simple equation (one unknown).

21. Rates and Percentages.

22. Ratio and Proportions.

23. Simultaneous Equations (2 unknown).

24. Similarity.

25. Tables and Charts (Construction, Reading and Interpreting).

26. Simple Linear graph (plotting, Reading and Interpreting).

27. Pythagora's Theorem.

28. Trignometric ratios - Sine, Cosine and Tangent.

29. Circles and Circular Measures.

30. Constructive Geometry (Angles, Shapes and Lines).

31. Symmetry.

32. Basic Algebra (Manipulation of Formula).

33. Indices.

34. Use of 4-figure tables (Squares, Logarithms, Trigs, etc).

35. Numerical (Arithmetic) Progressions.

36. Hand held Calculators.

37. Sine and Cosine Formulae.

38. Co-ordinate Geometry.

39. Flow diagrams for a Scheme of Work.

40. Gradients.

41. Probability.

42. Quadratic Equations.

43. Simple Linear Programming.

44. Introductory Calculus (Differentiation and Integration).

45. Standard Deviation.

46. Vectors.

47. Latitude and Longitudes.

48. Loci.

49. Complex Numbers.

50. Binomial Expansions.

APPENDIX D

FORM D

Please write E (endorse) against any of the mathematical item listed in table 1 if you consider them as a pre-requisite for the understanding of the technical trade content; and N (not endorse) if such an item is not a pre-requisite.

1	26
2	27
3	26
4	29
5	30
6	31
7	32
8	33
9	34
10	35
11	36
12	37
13	38
14	39
15	40
16	41
17	42
18	43
19	44
20	45
21	46
22	47
23	48
24	49
25	50

APPENDIX E

Raw Scores of The Technical And Mathematics Teachers on The Six Curricular Issues of the TCMC as Measured by the MCEQ.

S/NO	Programme			Qualification		Type		Curricular Issues					
	BD	EL	ME	PTT	NPTT	TT	MT	C_1	C_2	C_3	C_4	C_5	C_6
1.	X			X		X		7	7	7	6	5	1
2.	X			X		X		2	2	7	2	0	-1
3.	X				X	X		1	5	4	0	2	1
4.	X			X		X		6	3	4	5	4	1
5.	X				X	X		5	2	4	6	2	0
6.	X				X	X		3	6	2	5	2	1
7.	X			X		X		2	2	4	1	1	3
8.	X			X		X		6	6	3	3	6	2
9.	X				X	X		7	6	7	0	2	4
10.	X			X		X		6	6	6	7	3	4
11.	X				X	X		1	4	3	4	2	0
12.	X				X	X		-1	1	5	-1	-2	0
13.	X			X		X		3	4	5	7	2	4
14.	X			X		X		7	5	4	0	3	-1
15.	X				X	X		6	6	7	2	3	0
16.	X				X	X		6	3	2	3	5	1
17.	X			X		X		2	6	2	5	6	2
18.	X			X		X		7	5	5	4	6	0
19.	X				X	X		6	7	7	0	7	5
20.	X				X	X		5	6	7	6	6	1

	Programme			Qualification		Type		Curricular Issues					
S/NO	BD	EL	ME	PTT	NPTT	TT	MT	C_1	C_2	C_3	C_4	C_5	C_6
21.		X			X	X		5	3	3	5	3	-1
22.		X			X	X		7	7	6	7	4	1
23.		X		X		X		5	1	0	-1	3	-1
24.		X		X		X		5	4	6	6	3	0
25.		X		X		X		6	5	5	4	5	2
26.		X		X		X		7	7	7	7	7	4
27.		X			X	X		7	6	4	7	5	3
28.		X			X	X		6	5	0	2	2	0
29.		X		X		X		3	5	5	3	3	0
30.		X			X	X		7	7	6	7	4	2
31.		X		X		X		3	3	3	3	1	1
32.		X		X		X		4	4	7	5	2	2
33.		X			X	X		5	5	3	2	1	1
34.		X			X	X		5	4	3	5	5	1
35.		X		X		X		7	5	5	7	5	3
36.		X		X		X		4	3	4	3	4	2
37.		X		X		X		5	6	6	4	5	1
38.		X			X	X		6	7	7	5	3	0
39		X			X	X		5	5	7	4	3	1
40.		X			X	X		7	6	5	6	4	-1
41.			X	X		X		7	6	5	7	4	3
42.			X	X		X		3	3	4	4	1	3

	Programme			Qualification		Type		Curricular Issues					
S/NO	BD	EL	ME	PTT	NPTT	TT	MT	C_1	C_2	C_3	C_4	C_5	C_6
43.			X		X	X		7	7	6	6	5	3
44.			X		X	X		5	5	5	4	5	2
45.			X	X		X		4	3	0	5	3	2
46.			X	X		X		6	6	7	5	7	5
47.			X		X	X		7	6	5	0	2	1
48.			X	X		X		7	5	6	7	6	5
49.			X	X		X		6	5	6	6	7	1
50.			X		X	X		5	6	3	4	3	2
51.			X		X	X		3	0	3	3	-1	1
52.			X		X	X		4	7	6	7	5	4
53.			X	X		X		6	7	7	6	5	7
54.			X		X	X		6	6	5	6	6	4
55.			X	X		X		4	4	7	5	3	0
56.			X		X	X		7	5	3	2	6	2
57.			X	X		X		7	6	7	6	5	6
58.			X		X	X		5	7	5	7	3	6
59.			X		X	X		3	2	5	3	5	4
60.			X	X		X		7	7	3	5	7	5
61.							X	5	7	7	7	7	5
62.							X	4	4	4	3	3	1
63.							X	7	6	2	5	3	2
64.							X	7	7	7	7	7	7

S/NO	Programme			Qualification		Type		Curricular Issues					
	BD	EL	ME	PTT	NPTT	TT	MT	C_1	C_2	C_3	C_4	C_5	C_6
65.							X	7	6	6	6	5	4
66.							X	6	6	6	7	5	3
67.							X	6	4	6	6	5	3
68.							X	6	7	7	7	7	3
69.							X	4	4	5	3	3	2
70.							X	7	7	7	7	2	2
71.							X	6	6	7	5	1	2
72.							X	6	7	7	5	7	4
73.							X	5	7	7	5	4	3
74.							X	5	4	5	4	3	1
75.							X	4	4	4	3	3	2
76.							X	6	7	6	6	6	3
77.							X	6	7	7	6	7	4
78.							X	6	6	5	7	5	3
79.							X	7	7	7	6	7	4
80.							X	7	6	7	5	6	3
81.							X	5	7	6	5	6	2
82.							X	6	7	7	7	6	4
83.							X	7	5	6	6	5	3
84.							X	7	6	6	7	5	3
85.							X	7	5	6	6	7	4
86.							X	6	6	7	7	6	2

S/No	Programme				Qualification		Type	Curricular Issues					
	BD	EL	ME	PTT	F	TT	MT	C_1	C_2	C_3	C_4	C_5	C_6
87.							X	4	5	4	3	2	1
88.							X	7	6	6	7	7	2
89.							X	6	7	7	6	6	3
90.							X	7	5	5	6	5	2
91.							X	5	6	6	5	3	0
92.							X	5	7	7	6	6	3
93.							X	6	6	4	4	5	2
94.							X	7	6	6	6	5	4
95.							X	5	6	6	5	5	1
96.							X	7	6	7	4	4	3
97.							X	6	5	6	7	5	3
98.							X	7	7	6	5	7	4
99.							X	4	5	4	3	4	1
100.							X	6	7	5	6	7	2
101.							X	5	6	4	5	3	1
102.							X	7	6	7	7	5	2
103.							X	6	7	6	7	4	1
104.							X	6	4	6	6	5	3
105.							X	4	5	3	3	3	1

APPENDIX F

Summary Tables Showing The Mean Scores and Standard Divations of the Various Groups of Teachers on the Six Curricular Issues Raised on the TCMC as measured by the MCEQ.

1.

		Curricular Issues (Treatment)					
Maths Teacher		C_1	C_2	C_3	C_4	C_5	C_6
n=45	$\bar{X}$	5.89	5.93	5.78	5.53	4.93	2.67
	S.D	1.03	1.03	1.31	1.34	1.63	1.24
Tech. Teachers							
Composite	$\bar{X}$	5.08	4.92	4.75	4.20	3.83	1.88
n=60	S.D	1.88	1.76	1.89	2.31	2.04	1.99
Build. Trades Teachers							
n=20	$\bar{X}$	4.35	4.70	4.75	3.15	3.55	1.4
	S.D	2.48	1.81	1.83	2.58	2.42	1.76
Elotrical Trade Teachers							
n=20	$\bar{X}$	5.45	4.90	4.60	4.55	3.60	1.05
	S.D	1.32	1.62	2.11	2.14	1.50	1.39
Mech. Trades Teachers							
n=20	$\bar{X}$	5.45	5.15	4.90	4.90	4.35	3.20
	S.D	1.50	1.90	1.80	1.86	2.11	2.12
Professional Tech. Teachers							
n=30	$\bar{X}$	5.13	4.77	4.90	4.57	4.27	2.13
	S.D	1.73	1.58	2.01	1.93	2.00	1.98
No-Prof. Tech. Teachers							
n=30	$\bar{X}$	5.03	5.13	4.6	4.3	3.4	1.63
	S.D	1.74	1.69	1.83	2.24	2.00	1.54

2. The Harmonic mean $\bar{n}_h = \frac{pq}{\sum\sum(\frac{1}{n_{ij}})} = \frac{6x2}{6(\frac{1}{45}) + 6(\frac{1}{60})}$

$$= \frac{2}{1/45 + 1/60} = 51.43$$

3. $SS_{w.\ cell} = \sum\sum SS_{ij}$ (for the unweighted mean analysis)

$= 46.44+46.80 + ... + 234.18$

$= 1828.55.$

APPENDIX G

List of Mathematical Statistical Formulae and Test Statistics used in the Study.

1. Mean ($\bar{X}$ or μ) = $\frac{\sum x}{n}$

2. Standard Deviation (S.D) = $\sum \frac{(X-\bar{X})^2}{n-1}$

3. $SS_{ij} = \sum (X_{ijk} - AB_{ij})^2$

$= \sum X^2_{ijk} - \frac{(AB_{ij})^2}{n}$

4. $SS_{\text{within cell}} = \sum\sum S_{ij}$ (for unweighted means Analysis of variance); Winer (1962: 242).

5. (a) G^2/pq
   (b) $\sum x^2$
   (c) $\sum (C_i^2)/q$
   (d) $\sum (T_j^2)/p$
   (e) $\sum (CT_{ij})^2$
   (f) $(\sum p_k^2)/p$

   Note: Formulae 4 to 10 are used for computing AVOVA for unequal cell frequencies (pxq factorial Experiments) Winer (1962: 242, - 243, 306-318).

6. $SS_c = \bar{n}_h (5(c) - 5(a))$

7. $SS_T = \bar{n}_h (5(d) - 5(a))$

8. $SS_{CT} = \bar{n}_h (5(e) - 5(c) - 5(d) + 5(a))$

9. $SS_{\text{Between Subjects}} = 5(f) - 5(a)$

10. $SS_{\text{within Subjects}} = 5(b) - 5(d)$.

11. (a) $G^2/npqr$

(b) $\sum x^2$

(c) $(\sum A_i^2)/nqr$

(d) $(\sum B_j^2)/npr$

(e) $(\sum C_k^2)/npq$

(f) $\sum(AB_{ij}^2)/nr$

(g) $\sum(AC_{ik}^2)/nq$

(h) $\sum(BC_{jk}^2)/np$

(i) $\sum(ABC_{ijk}^2)/n$

(j) $(\sum P_m^2)/r$

Note: Formulae 11 to 22 are used in computing ANOVA for pxqxr Factorial experiments in which factor B is nested in factor A. Winer (1962:342-343).

12. $SS_{\text{Between Subjects}} = 11(i) - 11(a)$

13. $SS_A = 11(c) - 11(a)$

14. $SS_B = 11(d) - 11(a)$

15. $SS_{AB} = 11(f) - 11(c) - 11(d) + 11(a)$.

16. $SS_{\text{Subj. W. groups (Between Error)}} = 11(j) - 11(f)$

17. $SS_{\text{within Subjects}} = 11(b) - 11(j)$

18. $SS_C = 11/c) - 11(a)$

19. $SS_{\underline{AC}} = 11/(g)\ 11/c) - 11(e) + 11(a)$

20. $SS_{\underline{BC}} = 11(h) - 11(d) - 11(e) + 11(a)$

21. $SS_{\underline{ABC}} = 11(i) - 11(f) - 11(g) - 11(h) + 11(c) + 11(d) + 11(e) - 11(a)$

22. $SS_{CxSubj.\ W.\ groups\ (within\ error)} = 11(b) - 11(i) - 11(j) + 11(f).$

23. $Q = \dfrac{(K-1)\left\{K\sum B_i^2 - G^2\right\}}{KG - \sum L_i^2}$ Formula for cochran test, Leach (1978, 231-233).

24. $\bar{n}_h = \dfrac{pq}{\sum\sum \frac{1}{(n_{ij})}}$ where $\bar{n}_h$ is the harmonic mean, pand q are the levels of the two factors.

25. <u>Computation using the Turkey's T-Method.</u>

The following steps outlined by Glass and Stanley (1970:383-384) for multiple comparison using the T-method was adopted.

Step 1 All the differences between all the J_{C_2} i.e. 6_{C_2} in this case, were computed:- $\bar{X}_{.j} - \bar{X}_{.j*}$

Step 2 All the comparisons $\bar{X}_{.j} - \bar{X}_{.j*}$ are divided by square-root of MS_w/n where MS_W is the mean-square within factor levels and n is the number of observation in any group.

Step 3 The percentile point denoted by $(1-\alpha)\ Q\ (J, J(n-1))$ is found from the studentized range distribution.

Step 4 All the absolute vlues of the results in steps 2 are compared with the percentile point and $\bar{\bar{X}}_{.j}$ -and $\bar{\bar{X}}_{.j*}$ are significantly different if $|(\bar{\bar{X}}_{.j} - \bar{\bar{X}}_{.j*})| / \sqrt{MS_W/n}$ is greater than $(1 - \alpha)\, q\,(J, J\,(n-1))$

26. Cochran Test (Notes on its Selection and Usage).

As pointed out by Leach (1979: 231-235), the Cochran test was the most appropriate test statistic and was used in testing the sixth hypothesis. This is because, the responses of the extent of utility of each of the mathematics topics in mastery of the technical trades content was a two-categorical one involving several related samples. The samples are related since all the respondents share the same or similar technical background. The basic assumption of the Cochran test is that, there is no carry over effect, which was not suspected in the study. Even when such effect is available, it could be mitigated by randomising or counter-balancing the order of presentation of the different treatments. The following outline was followed.

1. Find K, which is the number of teachers in the study for each of the groups assessment (K = 10).
2. Selecting α, which is 0.05 in this study.

3. Focussing on one of the two categories, which was the endorsed (E), and counting the B_i, L_i and G.

4. Find $Q = \dfrac{(K-1)\ (K\sum B_i^2 - G^2)}{KG - \sum L_i^2}$ and compare this value with the critical value of Chi-square at (k-1) degree of freedom if nk 730.

5. If a significant result is obtained, use the Mcnemar test and do multiple comparison. In this study, no significant result was obtained and there was no need to use the Mcnemar test.