AN EVALUATION OF THE NATIONAL BOARD FOR TECHNICAL EDUCATION (N.B.T.E.) POLYTECHNIC MATHEMATICS CURRICULUM USING STAKE'S TRANSACTIONAL MODEL

BY

YUSUF ILIYASU

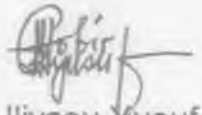
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DEDICATION

This study is dedicated to the memory of my late mother **HAJIYA HABIBA YUSUF.**

DECLARATION

I hereby declare that this thesis has been written by me. To the best of my knowledge, the topic has not been presented for a higher degree until now. All quotations are indicated and sources of information are duly acknowledged by means of references.

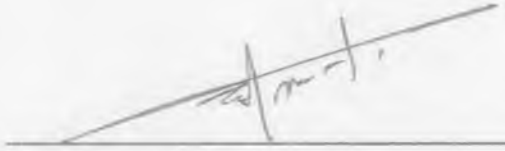


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CERTIFICATION

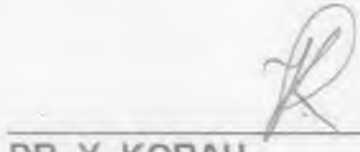
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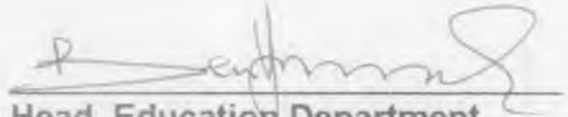
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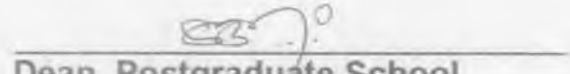
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ABSTRACT

The main purpose of this study was to evaluate the current N.B.T.E Polytechnic mathematics curriculum. The evaluation was undertaken with respect to the extent to which the curriculum objectives are attainable and the relevance of the curriculum objectives to current and future needs of students. A modified version of the Stake's transactional model of evaluation using a combination of the responsive and institutional self-study approaches was the research design adopted for this study.

56 mathematics lecturers and 158 engineering courses/subjects lecturers randomly selected from four Nigerian polytechnics in four different geo-political zones provided the data used in answering the six research questions and testing of the four research hypotheses. The instrument used was the Polytechnic Mathematics Curriculum Evaluation Instrument (PMCEI). This instrument comprises four sections with the first two sections being questionnaires and the last two being checklists for the assessment of the adequacy of both mathematics lecturers and learning facilities. Reliability coefficients of 0.73 and 0.76 were respectively established for the mathematics and engineering courses/subjects lecturers' questionnaires. The chi-square and t-test statistics were the data analysis technique employed. The following major findings were obtained (1) Majority of the lecturers teaching either mathematics or engineering courses possess the minimum qualification and adequate working experience to do so. (2) Mathematics lecturers do not differ in opinion among themselves on the attainability of the curriculum's general objectives. (3) The curriculum's general objectives are fairly attainable. (4) Engineering courses/subjects lecturers do not differ in opinion among themselves on the applicability of the curriculum's

contents to students areas of specialization. (5) Significant difference was found between mathematics and engineering courses/subjects lecturers opinions on the relevance of the curriculum's instructional objectives to the general objectives but non was found between the two groups on the relevance of the curriculum's contents to their objectives. (6) The curriculum's instructional objectives are relevant. (7) The curriculum's contents are relevant to their objectives. (8) No specific material provisions were specified for usage in teaching contents. (9) The curriculum's general objectives were not stated in behavioural terms. It was recommended that ways be devised to encourage mathematics lecturers to go and acquire higher degrees, the general objectives be reframed in line with standards of stating educational objectives, specific materials for successful implementation of contents be specified and the curriculum be retained.

Abbreviations and definition of terms

The following terms and abbreviations used in this study have the following meanings:

CESCAC	-	Comparative Education Study and Adaptation Centre.
Curriculum	-	A set of learning experiences designed to result in the attainment of set goals.
HND	-	Higher National Diploma: A certificate awarded by polytechnics or monotechnics.
MCEQ	-	Mathematics Curriculum Evaluation Questionnaire
N.B.T.E	-	National Board for Technical Education: A parastatal of the Federal Ministry of Education charged with the responsibility of overseeing the provision of all forms of technical education outside the universities.
ND	-	National Diploma: A certificate awarded by polytechnics or montechnics.
Perception	-	This refers to ones knowledge, understanding and conception about an issue, phenomenon or programme of events.
PMCEI	-	Polytechnic Mathematics Curriculum Evaluation Instrument.
STAN	-	Science Teachers Association of Nigeria.

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Chapter 1

THE PROBLEM

1.0 Introduction

Interest and involvement of the Nigerian government in the provision of western education to her citizens dates back to the era of colonial administration. The "Education Ordinance" of 1882 marked the first government legislation aimed at controlling educational practice in the Gold Coast Colony which Lagos was part of. Part of government's interest in this ordinance was the provision of special "Grants-in-Aids" to industrial schools. Hence, the 1882 Education Ordinance marked the first government interest and involvement with technical education. Thereafter, government showed more and continued interest in the education of natives by enacting series of ordinances with increasing financial commitment to the education sector.

Inspite of the above efforts, the educational situation of the natives remained highly unimpressive until the Phelps-Stoke commission's report of 1926. This report, which jolted government from its lukewarm attitude towards education of natives, found graveous lapses in the African education policies. It therefore came out with strong recommendations bordering on the adaptation of education to the needs of the various African communities (Fafunwa, 1971; Taiwo, 1980). The Phelps-Stoke commission's recommendations more than any other, guided the Nigerian educational policy and development up to 1945 (Fafunwa, 1971; Taiwo, 1980 and Osokoya, 1982).

The creation of Yaba Higher College, Lagos in 1939 was a big step forward in the development of technical education in Nigeria. For, this

college was later converted to a technical institute in 1948 as the first of its kind. Thus, the establishment of Yaba Higher college marked the first major step towards the full-scale institutionalization of technical education system in Nigeria.

The next major event, which influenced further development of technical education at higher level, was the recommendations of both the Asquith and Elliot Commissions set up in 1943. Both commissions recommended the creation of an inter-university council for education in the colonies. This point was later to be used as one of the "Cornerstones in the establishment of the first truly Nigerian polytechnic - the Nigerian college of Arts, Science and Technology in 1952". (Ukeje, 1979).

Educational development in the decade after independence was highly guided by the Ashby commission report of 1960. The report, titled "investment in education" made a big impression on the Nigerian education system. Specifically, it further stimulated the development of technical and vocational education by recommending the creation of technical streams in many secondary schools as well as the establishment of large technical colleges to make possible the production of 2500 technicians annually. The Ashby report is of great importance to the development of technical education in the sense that it influenced government to pay more attention to such education as an important means of meeting her manpower needs.

Evidence of government's effort to further develop technical education beyond secondary level can be located in the creation of Kaduna Polytechnic in 1961, Auchi Polytechnic in 1964, Institute of Management and Technology, Enugu in 1965, the polytechnic, Calabar and Katsina Polytechnic in 1973. Furthermore, the period between 1970 and 1980 witnessed the establishment of twenty polytechnics owned either by Federal or State governments (N.B.T.E. 1997). Worthy of mention at this juncture are three post-independence events that

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immensely contributed to the growth and development of technical education in Nigeria. These are the national conference on curriculum development of 1969, the release of the government white paper - The Federal Republic of Nigeria National Policy on Education and the establishment of the National Board for Technical Education all in 1977.

The report of the 1969 conference titled " A philosophy for Nigerian Education" promoted in substantial measure the subsequent development of technical education. It highly influenced all those concerned with education as a means to national development to come to realistic terms with the important role of science and technology in achieving such a noble dream.

The 1977 "Federal Republic of Nigeria National Policy on Education" (N.P.E.) added credence to the recommendations of the 1969 conference. After defining technical education as "that aspect of education which leads to the acquisition of practical and applied skills as well as basic scientific knowledge", the policy declared that there are five types of technical education institutions outside the universities. One of these, is the polytechnic. The 1981 revised N.P.E. further reiterates that among other things, technical education is expected to provide the following:-

(a) trained manpower in applied science, technology and commerce particularly at the sub-professional grade.
(b) technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic growth.
(c) people who can apply scientific knowledge to the use and convenience of man.

These expectations, being in agreement with the purpose of technical education as contained in the "Education (National Minimum Standards and Establishment of institutions) Decree 16" of 1985, have come to be the broad aims of the Nigerian polytechnic education. Thus, it

is not surprising that at present there is at least one polytechnic in virtually all states of the federation.

The National Board for Technical Education (N.B.T.E.) established by decree 9 of 1977 has some of the following functions as contained in its enabling decree.

(a) to advice the federal government and coordinate all aspects of technical and vocational education falling outside the universities and make recommendations on the national policy necessary for the training of technicians, craftsmen and other middle-level and skilled manpower,

(b) to determine, after consultation with the National Manpower Board, the Industrial Training Fund and such other bodies as it considers appropriate, the skilled and middle level manpower needs of the country in the industrial, commercial and other relevant fields for the purpose of planning training facilities and in particular to prepare periodic master plans for the balanced and coordinated development of polytechnics and such plans shall include:-

i) the general programmes to be pursued by polytechnics in order to maximize the use of available facilities and avoid unnecessary duplication while ensuring that they are adequate to the manpower needs of the country.

ii) recommendations for the establishment and location of new polytechnics as and when considered necessary.

iii) to lay down standards of skills to be attained and continually renew such standards as necessitated by technological and national needs.

iv) to review methods of assessments of students and trainees and to develop a scheme of national certification for technicians, craftsmen and other skilled personnel in collaboration with ministries and organizations having technical training programmes.

Based on the above information, the N.B.T.E. "has laid down standards of skills to be attained by diplomates of technical institution through evolving new curricular for existing programmes and new

programmes in fields where such manpower is badly needed to enhance agricultural, commercial, industrial and economic development" (N.B.T.E. 1987). The current mathematics curriculum for courses offered by Nigerian Polytechnics, published in 1990, is one of these curricular.

1.1 Statement of the problem

Research evidence available to the researcher through literature review revealed that no research has been conducted on the current mathematics curriculum for Nigerian polytechnics. Consequently, information on the extent to which the curriculum objectives can be met is virtually not available. Suppose such information had been available, it might have the potential of assisting decision makers to make meaningful improvements in the curriculum (Saylor, Alexander and Lewis, 1981; Finch and Crunkilton, 1984). Can the absence of this evaluation information be a reason why changes geared towards improvement have not been carried out in the curriculum over the years?

It is this researcher's contention that the absence of post-implementation evaluation on how well this curriculum has fared has led to the creation of two major problems. The first is on how to address students major complains about the contents of the curriculum. Over the years in which this researcher has been using this curriculum, a persistent complain of students is that the content have no direct bearing on their areas of specialization. These complains, having span a period of over eight years of this researcher's teaching experience using this curriculum, has led to students exhibition of some observed low level of motivation and interest in the study of the subject. This has considerable negative effect on their performance in the subject.

The second problem area observed by this researcher is in the framing of the objectives. The curriculum objectives were not behaviourally stated e.g "on the completion of this course, the student will be able to understand the laws of indices and applications in simplifying algebraic expressions" is one among all the objectives not stated behaviourally. This is contrary to established mode of stating educational objectives.

The above fundamental aspects of any curricular entity, which were not taken care of in this curriculum, formed the basis on which this research is hinged. The major concern, therefore, of this research is to evaluate the current polytechnic mathematics curriculum so as to assess the adequacy of the objectives and contents vis-à-vis the current and future technological needs of Nigeria.

1.2 Research Questions

This study attempts providing answers to the following questions.

1. What are the characteristics, in terms of highest educational qualification and length of service of the mathematics lecturers and their non-mathematics counterparts teaching engineering courses /subjects in the polytechnics studied?
2. To what extent are the general objectives of the current N.B.T.E polytechnic mathematics curriculum attainable?
3. How relevant are the instructional objectives of the current N.B.T.E polytechnic mathematics curriculum to the general objectives?
4. To what extent are the contents of the current N.B.T.E polytechnic mathematics curriculum relevant to their objectives?
5. How balanced is the scope/area of coverage of contents of the current N.B.T.E polytechnic mathematics curriculum in relation to its general objectives?

6. To what extent are the resources (human and material) needed for the successful implementation of the current N.B.T.E polytechnic mathematics curriculum adequate in the institutions covered during research?

1.3 Research Hypotheses

In order to answer the above research questions raised in the preceding section, the following hypotheses, stated in the null from, were tested.

Ho_1: There is no significant difference among the opinion of the mathematics lecturers regarding the attainability of the general objectives of the current N.B.T.E polytechnic mathematics curriculum.

Ho_2: There is no significant difference between the mean opinion of the mathematics lecturers and those of the engineering courses/subjects lecturers regarding the relevance of instructional objectives to the general objectives of the current N.B.T.E polytechnic mathematics curriculum.

Ho_3: There is no significant difference between the mean opinions of the mathematics lecturers and those of the engineering courses/subjects lecturers concerning the relevance of the contents of the current N.B.T.E polytechnic mathematics curriculum to its objectives.

Ho_4: There is no significant difference among the opinions of engineering courses/subjects lecturers regarding the applicability of

contents to students areas of specialization in the current N.B.T.E polytechnic mathematics curriculum.

1.4 Purpose of the study

The main purpose of this study is to evaluate the current mathematics curriculum for Nigerian Polytechnics in order to assess its adequacy for Nigeria's present and future technological needs. The study will specifically evaluate the curriculum with respect to:

1. The extent to which the curriculum objectives are attainable.
2. The relevance of the curriculum objectives to the current and future needs of the students.
3. The adequacy of the contents of the curriculum to Nigeria's present and future technological needs.

Another purpose of the study is to suggest or offer advice on how the curriculum objectives could be more realised.

1.5 Justification and Significance of the Study

Kyeleve (1988) observed that several mathematics curriculum studies such as NERC (1977), Ohuche (1978), Osibodu(1976), Igboko (1983), Badmus (1978, 1986) and Williams (1974) were directed towards secondary schools, Grade II teacher's college or primary education. Since Kyeleve's (1988) research work on mathematics curriculum for technical colleges, researchers started paying attention to curriculum studies for technical colleges.

In addition, this researchers review of available literature revealed that no study has been conducted on the mathematics curriculum for Nigerian Polytechnics. Since 1990 when the N.B.T.E introduced this curriculum for Nigerian Polytechnics, the need to undertake an evaluative research work on it has become imperative, this is more so when viewed

along with the fact that we have entered a new millennium when a lot of technological knowledge is what essentially matters in our everyday activities.

Thus, this study which has been designed to provide a post implementation evaluation of the current mathematics curriculum for Nigerian Polytechnics will asses the adequacy of its objectives and content. The findings will be of immense benefit to mathematics lecturers in Polytechnics towards making their teaching more effective. In particular, it will help them in the determination of the effectiveness of their instructional programmes by making it easier to be able to check accomplished results against objectives.

In addition, it could also be used by Polytechnic lecturers as a means through which standards of students achievement will be more clearly defined, more carefully differentiated and better adapted to their different kind of capabilities and individual levels of attainment. Policy makers, especially the N.B.T.E will also benefit from the findings of the study with respect to the effectiveness and relevancy of the curriculum towards helping the nation attain its manpower requirements. Thus, future curriculum developers can take these factors into consideration.

Finally, the study will provide a frame work for similar research efforts in the future to cover all other subjects in Nigerian Polytechnics and other tertiary institutions of our education system.

1.6 Scope and Delimitation of the study

The main focus of this study is to evaluate the current mathematics curriculum for Nigerian Polytechnics developed by N.B.T.E. and introduced in 1990. The study covered the two-year National Diploma (ND) mathematics curriculum programmes and the two-year Higher National Diploma (HND) mathematics curriculum programmes for

engineering. These two curriculum programmes, in conjunction with those of other subjects, qualify diplomates for the award of the ND and HND certificates in their various areas of specialization. Other N.B.T.E mathematics curricular for Nigerian Polytechnics such as the Pre-ND mathematics curriculum and the Post-HND mathematics curriculum were not examined in this study.

In terms of coverage of subjects used, the study used mathematics lecturers and their counterparts teaching engineering courses/subjects in the four polytechnics in Nigeria generally referred to as the first generation polytechnics. These institutions are the Yaba College of Technology, Lagos; Kaduna Polytechnics, Kaduna; Institute of Management and Technology, Enugu; and the Auchi Polytechnic, Auchi. The two sets of lecturers used were chosed because they are very conversant with the curriculum targeted for evaluation.

1.7 Summary

This chapter starts by briefly outlining the historical development of technical education in Nigeria. It was seen that technical education in its formal setting is as old as other forms of western education in Nigeria. Also, governments' participation in the provision of technical education to its citizens was traced to the "Education Ordinance" of 1882. Thereafter, government's participation in the provision of this type of education increased substantially by way of enacting series of ordinances, decrees and establishment of commissions to cater for its provision. Financial commitments also increased tremendously during these periods. All these efforts were linked to the establishment and development of the Nigerian Polytechnic education system up to its present status. This discussion formed the background information to this study.

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The research problem emanated from three distinct but related problem areas. These are:

(1) the absence of evaluation information on how well the curriculum has fared, which could have spurred an effort to revise the curriculum.

(2) students constant complains that the curriculum content is not adequately relevant to their areas of specialization and

(3) the manner in which the objectives of the curriculum were framed.

The purpose, justification and significance of the study were carefully articulated. In this wise, the study was embarked upon primarily to evaluate the current mathematics curriculum for Nigerian Polytechnics in order to assess its adequacy for Nigerian's present and future technological needs. The justification for the study can be located in the fact that since the introduction of the curriculum in 1990, no post-implementation evaluation study was undertaken on it, therefore, the need to do so now has become imperative. In addition, the findings will benefit polytechnic lecturers and policy makers.

Seven research questions and four hypotheses were raised which the study attempts to provide answers and test respectively. Finally, the scope and delimitation of the study were specified.

Chapter 2

REVIEW OF LITERATURE

2.0 Introduction

Literature available to the researcher reveals that there is no published research work bordering on the evaluation of Nigerian Polytechnics mathematics curriculum. However, it was discovered that several curriculum studies in mathematics education have been directed towards other levels of our education system, particularly the primary and secondary. It was also found that several studies in mathematics for this level and type of education have been conducted in other parts of the world.

Consequently, it is only pertinent that one relates the implications of these studies and reports to the situation in Nigerian Polytechnics in general and this study in particular. Hence, the reviews are presented from two main perspectives, namely: the theoretical frame work and the previous studies. Therefore, this chapter has been divided into the following subheadings:

1. Factors in curriculum planning
2. Models of curriculum development
3. Curriculum change
4. Curriculum evaluation
5. Models of curriculum evaluation

6. Mathematical studies in educational technology
7. Related curriculum evaluation studies.

2.1 Factors in Curriculum Planning

Curriculum planning has been described as a choice oriented process in building a programme of learning experiences calculated to result in the attainment of set goals (Kelly, 1982). It is observed that the terms curriculum planning, curriculum design, curriculum innovation and curriculum development are used interchangeably to convey the same idea (Wheeler, 1967; Nicholls and Nicholls, 1972; Kelly, 1982; Kyeleve, 1988). It therefore follows that the general purpose of curriculum planning is to design a programme of education for a society which can foster its ideals and values as well as lead to maximum attainment of social, economic and other needs.

Inherent in the notion of curriculum planning is that it is a "process", which implies that it is dynamic and not static in nature. This is not unexpected, since the human society is equally dynamic and curriculum must reflect its aspiration. Secondly, the concept of process refers to the different levels curriculum planning involves. Between the top planning level where the total educational programme is conceived and generally designed, and the classroom planning level where the final action of implementation is taken, there are usually, a number of intermediate planning levels (Olivia, 1972). Literature available to this researcher revealed that there is no established number of planning levels common to all curriculum development efforts. The number of planning levels and nature depends on the organisational structure and control process of the education system.

The question of "who plans the curriculum?" is an important factor in curriculum planning which attracts a wide range of different answer, depending on the view of the proposer. Many authorities on curriculum studies (e.g. Tanner and Tanner, 1975; Onwuka, 1981; Kelly, 1982) pointed out that formerly such individuals were drawn from the class of professionals comprising educational administrators, curriculum experts and subject specialists. But the modern practice embraces both professionals, teachers, lay citizens, parents and learners.

This modern option rests on the fact that curriculum experience has been seen as choices by the participants in educational operation; and hence a more adequate and appropriate curriculum for a society is most likely to result from professionals and representatives of society engaged in the planning if they work together in close cooperation. The rationale for this cooperative planning effort can easily be discerned. Since the determination of experiences is a difficult and complex task, all segments of the society which benefit from education or expect education to serve them, should contribute to the planning of the programme (Kelly, 1982).

The role of each group in this kind of cooperative planning approach to curriculum development has been discussed at length by Kelly (1982). The experts, by their knowledge and skills carry out these technical skills, viz:

(i) organizing and structuring the curriculum to become an adequate and high quality teaching - learning instrument.

(ii) provide leadership to help the entire community determine the nature and scope of their curriculum.

(iii) act as technicians in devising and executing a concrete plan for carrying out decisions made cooperatively.

The role of parents and lay citizens is to suggest and help define appropriate objectives and the desired outcomes of the school

experiences, acceptable and appreciable for its citizens. Their involvement at the evaluation stage is also very important and crucial. As parents and citizens who are in contact with the learners, they occupy a very strategic position than other groups of planners to assess the effectiveness of the school programme. Their assessment can be a very useful guide for future curriculum planning decisions and actions especially at the lower levels of educational planning.

The respective contributions of teachers and learners, the last two groups of the planning team, are indispensable. Teachers share in the overall task of curriculum planning and implementation. This obligation is very crucial and challenging, because no matter how well and carefully a curriculum is constructed, its degree of adequacy and relevance can highly be guaranteed by teachers. As teachers work with learners, they determine which of the proposed educational experiences the learners must acquire. It is based on this fact that the current study attempted to draw heavily from the opinion of polytechnic mathematics teachers and their counterparts teaching engineering subjects.

The two main problems usually faced by teachers in translating a planned curriculum are;

(i) making sure that experiences they encourage learners to acquire closely correspond to the intended experiences.

(ii) that the set of experiences each learner acquires is consistent with his background, interest and motivation.

Learners, on their part, select and acquire the right kind of experiences only through the guidance of the teachers. In particular, they work with teachers to determine appropriate instructional objectives, decide on appropriate experiences and choose instructional procedures that can best lead to the attainment of the objectives. They may also serve as resource persons and help generally in assessing and evaluating the overall curriculum. This is particularly more realizable from

learners in tertiary institutions. For this reason, some of the parameters to be used in evaluating the Nigerian polytechnic mathematics curriculum in this study will in addition be based on teachers' assessment of learners' opinions and academic work.

2.2 Models of curriculum development

Educational programmes, like any activity which is result oriented in nature depends on proper planning for its success. The process of planning learning opportunities intended to bring about changes in the learners, and that of planning the procedures of assessing the extent to which these changes have taken place is what is called curriculum development (Nicholls and Nicholls, 1972). Various models have been proposed for curriculum development. Tyler's (1949) four fold analysis of the curriculum is one of the earliest of such models. This model suggested that curriculum planning should be seen as consisting four dimensions, viz: objectives, contents or subject matter, methods or procedure and evaluation. This model infers that the curriculum planner must distinguish between the following; what is hoped to be achieved, the amount of work to be done in order to achieve it, the kinds of activities and methods considered likely to be most effective in helping to achieve it and the devices intended to be used to evaluate what have been done.

Bossing's (1964) model reported by Kyeleve (1988) has the following major steps.

1. Statement of social and educational philosophy.
2. Statement of accepted basic principles of learning.
3. A clearly defined concept of the curriculum.
4. Statement of the aims of education.
5. Scope and area of curriculum and course guide.
6. Sequence and time allotment.

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7. Determination of contents, materials and activities.
8. Suggested organization of content, materials and activities.
9. Suggested teaching procedure.
10. Suggested evaluation procedure.
11. Pupil - teacher reference materials, and
12. Mechanical make - up of course guides.

Kyeleve (1988) observes that most models of curriculum development have much in common, the areas of difference being in the steps because the steps involved in some are merged in others. With regards to Tyler's (1949) and Bossing's (1964) models cited above, it can be seen that in trying to determine what educational purposes the school should seek, the curriculum developers have to have a clear social and educational philosophy, accepted basic principles of learning, concept of curriculum and the aims of education. Also, attempt to determine what educational experiences should be provided learners so as to achieve the objectives entails determining the scope and area of curriculum, sequence and time allotment of chosen content, materials and activities to be embedded in the curriculum

Thus, steps one to four of Bossing's model are contained in step one of Tyler's, steps five to eight are contained in step two, steps nine and ten corresponds respectively to steps three and four. Perhaps, it is in realization of these similarities that Onwuka (1981) asserts that there are four major stages in the process of curriculum development. These are;

(1) The selection of aims, goals and objectives.
(2) The selection of appropriate learning experiences and contents for the achievement of the aims, goals and objectives.
(3) Organization of learning experiences, and
(4) Evaluation of the extent to which the objectives identified in step one have been achieved.

The write-ups of Havelock (1971) and Hawes (1979) as revised by Shirley (1984) is worth noting. Havelock gave a model with three major steps. These are research, development and diffusion (R, D and D). The models cited above are embedded in the research and development levels of this model. The diffusion level deals with the manner in which the developed ideas are to be disseminated. Thus, the dissemination level deals specifically with implementation strategy.

The model proposed by Hawes can be said to be an elaboration of Havelock's, where six steps are involved. These are;

(1) Gathering information on the content
(2) Deciding aims and objectives
(3) Planning a strategy of change
(4) Actual curriculum development
(5) Implementation in schools
(6) Evaluation.

Again, it can be seen that the "research level" of Havelock's model contains the first two steps of Hawes's, his "development level" contains steps three and four of that given by Hawes. Finally, the "diffusion level" deals with implementation in schools, which is the last but important stage of the evaluative process.

Kelly (1982) argued that the above models are too simple and summed them up as a "linear model" which makes no sufficient allowance for the inter-relatedness of the separate elements. This implies that a provision should be made to allow the process of evaluation to be used to modify planning if the need arises. Thus, researchers have suggested the employment of a cyclical rather than linear model where evaluation is linked to framing of objectives to create a continuous cycle (Wheeler, 1967).

However, Onwuka (1981) opined that these steps may be considered linear from the point of view of both time and the operations

involved. But, that if our conception of aims is deriving from the existing societal situation rather than being externally imposed, the function of identifying must be interdependent with the steps. Therefore, the four steps would be interdependent functions rather than linear sequential steps.

Therefore, curriculum development process whether seen as linear or cyclical, must fundamentally begin with a statement of objectives. Hirst (1969) argued that this is necessary if curriculum development is to qualify as a rational activity. Proponents of this approach advanced four reasons (logical, scientific, politico-economic and educational) for urging it on planners (Kelly, 1982).

The logical argument claims that what characterized a rational activity is its being directed at some clear goals or set of purposes. Therefore, if education is to be regarded as a rational activity, it must state its goals or purposes at the beginning. The scientific argument represents an attempt to bring into educational practice some precision and technological efficiency that is admired as the key to advances elsewhere and thus render it more respectable. The contention here is that the application of scientific method to education practice can only be effective if objectives are pre-specified.

The socio-economic reason has it that since educational provisions are made at the expense of the taxpayers and that since most curriculum development is financed in the same manner, the tax payer is entitled to a clear statement of what his/her money is being spent on and the intent to be achieved by it. More significantly, there must be a careful evaluation of the effectiveness of school programmes and other levels of curriculum planning in order to ensure that public money is not being wasted and therefore, the country not being deprived of talents and skills its economic welfare require from its citizens. Such evaluation, this claim

contends, can only be made properly if it is based on a clear statement of intentions.

Lastly, the educational reasons advanced in support of the pre-specification of objectives is based on the assumption that evaluation requires such pre-specification. In this wise, Taba (1969) upholds that it is crucial for evaluation which in turn is crucial for effective teaching, continued presence of certain subject on the curriculum and for curriculum development itself.

Curriculum development by pre-specification of objectives approach is not universally accepted. Kelly's (1982) contention is that it raises some fundamental theoretical issues concerning the nature of education and man. For example, it attempts to reduce education to a scientific activity analogous to the processes of industry. Furthermore, this type of industrial approach assumes that it is legitimate to mould human beings by modifying their behaviours according to certain clear cut intentions without making any allowance for their own individual wishes, desires or interests.

Hence, the implication is that human behaviour can be explored, analyzed and explained similarly as the behaviour of inanimate objects. This therefore implies that scientific methods similar to the ones used by physical scientists can be used to study human behaviours and can be explained in terms of causes rather than purposes. This view is inconsistent with that of those who regard man as a free and active agent responsible for his own destiny and who, as a direct consequence of this, believe it to be morally wrong to deny him that responsibility and freedom by attempting to mould his behaviour to suit someone else's. Such a process, opposers of the pre-specification of objectives approach to curriculum development argue, is indoctrination rather than education and thus should be deplored.

Proposed alternatives to the pre-specification of objectives approach to curriculum development lay emphasis on the other elements of Tyler's four fold analysis of the curriculum (Ndubisi, 1981; Barnes, 1982). Ndubisi (1981) opined that since stating of the content of education is another approach to curriculum development, which lays emphasis on Tyler's second element of curriculum, it can still be viewed as the same as the pre-specification of objectives approach. For, in this case, the contents becomes the focus of education. To plan a curriculum using this other approach entails stating what subjects and perhaps aspects of them are to be studied, and to answer questions about the purpose for their study in terms of some intrinsic value rather than extrinsic ends they are held to serve.

Another approach (Barnes, 1982) is that which emphasizes that element of Tyler's analysis referred to as procedures. The main concern here is with methods of learning. Predicated on the view that education is centrally concerned with certain processes of cognitive development, this approach therefore upholds that what is crucial to education is neither the bodies of knowledge assimilated, nor the behavioural objectives attained. It is also not the behavioural changes brought about, but the process of development promoted (Blenkin and Kelly, 1981). Based on this view, curriculum planning must start with a clear statement of the processes it is concerned to promote, and thus the procedural principles upon which the teacher's day to day decisions and judgement are to be based. Kelly (1982) argued that such principles are even a prerequisite of other models too, since some criteria of this kind are a necessary basis both for initial selection of objectives or contents and for the continuing modification of these in the light of subsequent evaluations.

2.3 Curriculum change

The idea and need to modify an existing curriculum so as to provide a better programme may originate at any point in the curriculum development process. This modification may be with regards to the objectives, contents, methods or even evaluation procedures. Even the entire curriculum may be changed. When the learning experiences that learners are exposed to are affected as a result of changes in any of these (i.e. objectives, contents, methods and evaluation procedures), we conclude that curriculum change has taken place.

Reasons normally advanced for curriculum change seem to be universally accepted. One of such is that since the curriculum is an instrument through which societal belief, values, aspirations and ideals are transmitted to the young and since these do change with time, then such changes have to be reflected in the curriculum if it is to serve the purpose it is meant for. Changes in national objectives necessitate curriculum changes. For instance, during the era of colonial administration, the Nigerian curriculum was structured towards the production of clerks for offices, teachers and missionaries for evangelism. However, after the attainment of self governance, the curriculum was revised to take accounts of the new goals of education.

A second factor that necessitates curriculum change is the advent of new bodies of knowledge. For, knowledge is not static. New discoveries usually set waves of changes in subject matters. Because education serves, among other things, to initiate the young into the realm of knowledge, these changes in subject matter therefore demand renewal of curriculum.

Advances in teaching methods is a third factor that necessitates curriculum change. Whenever there are new facilities that can aid learning it becomes reasonably necessary to revise the curriculum so that

better learning experiences can be organized to meet the intended objectives. Computers being used now have led to revisions of curriculum in many developing countries e.g. Malaysia, South Africa, Ghana, etc. Also, researches in educational psychology have resulted into insights on how teaching occurs. These have in turn affected teaching methods and techniques. Examples of these can be located in Bruner's. (1966) work on discovery learning and Piaget's (1962) theory of intellectual development. These works have greatly influenced the planning and structuring of learning experiences to suit learners probable level of intellectual functioning.

A consistent evaluation of curriculum from time to time will reveal why and where revision is due. The result of curriculum evaluation is thus another factor that necessitates curriculum changes. These reasons that necessitates curriculum change makes it imperative that for any curriculum change to be meaningful, it has to be in response to any or a combination of the following areas of change:

(i) objectives of education
(ii) the nature of knowledge or content of education
(iii) existing knowledge about learning process
(iv) the system of education
(v) feedback from evaluation.

Next in this discussion is the process of curriculum change. Based on the experiences of Science Teachers Association of Nigeria (S.T.A.N) and Comparative Education Study and Adaptation Centre (C.E.S.A.C) attempt at curriculum renewal in Nigeria, Onwuka (1981) proposed the following procedures as those involved in proper curriculum change.

(i) identifying the aspect of the curriculum to be revised
(ii) involving all concerned with the production and translation of a curriculum e.g. curriculum experts, school teachers, administrators, content experts etc.

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(iii) providing actual curriculum materials - pupils texts, teachers guide, work books emphasizing audio visual aids etc.

(iv) providing training courses for teachers from selected pilot schools

(v) producing curriculum packages to be subjected to field tests in the selected pilot schools for an intended period of time

(vi) entertaining feedback from trial in pilot schools

(vii) revising curriculum materials in the light of feedbacks

(viii) producing and introducing curriculum packages to all schools for possible adoption or adaptation

(ix) periodically evaluating curriculum for any necessary modification

The process of curriculum change cited above demands cooperation of people knowledgeable in curriculum development, experts in subject areas, practicing teachers and school administrators. It should be observed that these phases of curriculum change approximate the stages in curriculum planning discussed in section 2.2.

Besides these mentioned procedures, other factors are still required for any curriculum renewal to be effective (Onwuka, 1981; Kelly, 1982). First, teachers must be involved in decision making and actual development/production of curriculum materials. This is because teachers, in the long run, will implement the change. Also feedback from teachers who have used a particular curriculum are essential for future meaningful revision. Teachers' capabilities to successfully effect the desired change is another factor that must be considered. New curricula usually call for knowledge, understanding and other abilities. These, the teachers must posses. Therefore, mechanism for taking care of these must be put in place. Thirdly, revision involves a lot of money. New methods of teaching may have to be adopted, existing curriculum materials including costly equipments may have to give way to new ones. Production of new materials and techniques are costly and so, may not be available. Where the materials are not available, the curriculum

implementation is bound to fail. The 6-3-3-4 system in Nigeria is an example.

Conservatism by teachers and administrators can threaten the success of curriculum change. Many teachers and administrators possess undefined fears concerning changes (Kelly, 1982). Organizational health of schools is the fifth point that can affect curriculum change. Since the new curriculum has to be practiced within the school system, if this system has no allowance for the time schedule required by that curriculum, problems may arise which could inhibit the success of the curriculum change. The implication here is that in planning any change, the new materials should be such that the school setting can accommodate them.

Finally, dissemination of curriculum is crucial for the success of any intended curriculum change. Macdonald and Walker (1976) remarked that the term "dissemination" indicates planned pathways for the transmission of the new educational ideas and practices from their point of production to all locations of potential implementation. This process, according to them, has the potential of improving the channels of curriculum change, accelerating its speeds, improving the quality of the curriculum and making it possible for greater cost effectiveness to be envisaged.

This assertion probably accounts for the different models of dissemination in existence today. Kelly (1982) noted Schon's (1971) and Havelock's (1971) efforts as being the two major attempts to identify different models of dissemination. Schon identified three models. These are the centre - periphery, the proliferation of centres and the shift centres models. Havelock also identified three models. These are the research, development and dissemination, the social interaction and the problem solving models.

The centre - periphery model sees dissemination process as being centrally controlled. Therefore, innovation is to be planned and prepared in detail prior to its dissemination and that the process of dissemination is one way from the centre out to the consumers at the periphery. In Nigeria, this model seems to be most favoured. All curricular innovations right from the time Nigeria attained self-governance have been disseminated using this model. This probably is due to the heavy involvement of the government in the provision of education for its citizens. In particulars, the curriculum that is being evaluated in this study has been disseminated using this model. The strength of this model depends on the central resources, the number of points on the periphery that are to be reached and the length of the distance between these points from the centre.

The proliferation of centres model attempts to overcome the above factors or at least reduce their significance by creating secondary centres to extend the reach and thus, the efficiency of the primary centre. The shifting centres model, posited to explain changes in values and attitudes of a more subtle and less deliberate kind, is characterized by the absence of any clearly established centre and of any stable, centrally established message. In the U.S.A, this model of dissemination has found general acceptance because most of the different state determine what kind of educational diet should be dished out to their citizens. This has an added advantage of healthy competition among various centers which also makes room for faster rate of curriculum development.

Kelly (1982) opined that the three models above appear to be more successful at explaining how planning diffusion occurs than at offering a strategy for planned dissemination. Schon believes it has potential value for curriculum change but Kelly has questioned this assertion based on Stenhouse's (1975) argument that this model appears to offer no basis for the development of any specific message.

The research, development and dissemination (R, D and D) model is an attempt to take dissemination beyond the notion that it must always assume a one way centre-periphery approach. This model assumes a developer who identifies the problem and a receiver who is essentially a passive recipient of innovation developed to resolve that problem. It is a "target system" recommended for use when large scale curriculum change is the aim. This model has many affinities with the centre-periphery approach. As the difficulties of the centre - periphery approach emerged, two major steps were added to this process - those of adoption and implementation. This again, represents a move towards the more deliberate planning of dissemination.

Havelock (1971) reported that the social interaction model places greater stress on the interaction between members of the adopting group. Though, this model is a form of centre-periphery model where the central planners determine the needs of the consumers, it recognizes that the key to the adoption and successful dissemination of innovation is the social climate of the receiving body. Thus, the question of success or failure of innovation will hinge on the channels of communications within the receiving body. This model, like the proliferation of centres model, represents the beginning of a shift of focus from the centre to the periphery.

The problem solving model attempts completing the above shift. (Havelock, 1971) The essence of this model is that the problem is identified by the consumer and the process of dissemination is thus indicated also by him. The recipient on the periphery is therefore active because of his involvement from the beginning. The process here, is one in which he essentially recruits outside help. The relationship between consumer and the external support agent is one of mutual collaboration rather than that of the receiver and sender of message.

Taking an overview of these models of dissemination, it can be easily seen that a good deal of overlapping exist between them. The major division is between those which adopt a centre-periphery approach of central development with planned dissemination, and those which encourage initiatives from the consumers. The later have led to the development of the notion of the school - based curriculum development. This is a curriculum development strategy where the processes of curriculum development are to be initiated from the school, with the teachers constituting the major participants.

Proponents of the school - based curriculum development approach claim that some problems are endemic to the other approaches which make them quite inadequate as devices for effective curriculum change. One of these problems, they noted, is the wide gap that normally exists between ideas held by central planners of a project and the realities of its implementation. Stenhouse (1975) considers this gap between policy and practice as the central problem of curriculum development in education. In addition, Kelly (1982) observes that in some cases, project implementors have taken the project ideas/materials into separate parts for use which suit their own purposes rather than those for which they were intended. This can lead to an improper implementation of the innovation and the consequence of this can be quite disastrous.

The school - based curriculum development approach makes it imperative for one to realize that for innovation to have a chance in schools, more provision of resources and in-service support for teachers are not just adequate (Stenhouse, 1975). Teachers must be committed to it and ideological changes promoted if they are to willingfully adopt their methods and approaches to meet the demands of the new work.

There are several major principles which are reflected in this notion of school - based curriculum development. First, it is based on the belief that the curriculum should consist of experiences which are developed

from the learner's needs and characteristics (Skilbeck, 1976). Secondly, it acknowledges that a large measure of freedom for both teachers and learners' is a necessary condition for education of this kind (Skilbeck, 1976). Thirdly, it views the school as a humane and social institution which must be responsive to its environment and which must therefore be permitted to develop its own way to fit that environment (Skilbeck, 1976).

Lastly, it regards it as vital to this curriculum development approach that the individual teacher, or at least the staff of any individual school should accept a research and development role in respect of curriculum (Stenhouse, 1975), modifying, adapting and developing it to suit the needs of individual pupils and particular environment.

In conclusion, it is worth remarking that the ability of teachers to promote the development of curriculum is dependent on their ability to evaluate its effectiveness. Thus, curriculum development and evaluation are integrally linked together. The role of the teacher in one cannot be properly discussed except in association with his role in the other.

2.4 Curriculum evaluation

A major feature of the planned attempts at curriculum innovations discussed in the preceding section has been the development of a range of techniques to measure the effectiveness and, in some cases, the desirability of such innovations. These have led to the emergence of a more involving and complex area of study within curriculum theory i.e. curriculum evaluation. Dressel (1985) posited that curriculum evaluation involves some or all of the following elements:

1. identifying and examining the values inherent in the programme, policy or procedure to be evaluated,
2. formulating or clarifying the objectives, goals, purposes of the programme,

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3. determining the criteria for measuring success,
4. defining, obtaining, analyzing and interpreting data and other information,
5. determining and explaining the extent of success and failure,
6. indicating the relationship between experiences during the programme and the outcome of the programme (impact of various programme variables),
7. identifying planned and unplanned (side) effects,
8. determining the impact of the programme and the impact of external uncontrolled variables,
9. recommending the alteration, replacement or discontinuance of the programme or of individual features of the programme,
10. setting up a continuing review of programme results.
11. assessing the value, benefit or social utility of the programme, objectives and process of, and of education itself.

The current study involves the first, third, fourth, sixth, eight, ninth and eleventh elements of evaluation above. These are reflected in chapters one, three, four and five. In chapter one, the values inherent in the polytechnic education system of Nigeria have been identified and discussed. This is in relation to the curriculum being evaluated. In chapter three, the criteria to be adopted for conducting the research, referred to above as "criteria for measuring success", have been articulately mapped out. Chapter four dwells on the analysis and interpretation of the data to be gathered. Chapter five discusses the impact of the curriculum on the polytechnic education system and suggestions for improvement of certain curriculum aspects proffered.

The above elements imply that evaluation is the collection and interpretation, through systematic and formal means, of relevant information which serves as the basis for rational judgements in decision situations. If evaluation is ultimately justified as a basis for decision

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making, it becomes necessary to consider the types of decisions to be made. Dressel (1985) identified the following four types:

(1) Decisions on intended ends. Objectives may require alteration or clarification. Some may be unachievable with existing constraints implying that more realistic and equally desirable ones will have to be found. In this area, evaluation is concerned with determination of needs and with general nature and objectives of a programme designed to meet these needs.

(2) Decisions on intended means. Process may be ineffective or require clarification and refinement. Better prepared teachers and revised materials may be needed. Costs may be too high. In this area, evaluation is concerned with setting, designing and sequencing procedures and with delineating and analyzing the relative merits of alternative procedures.

(3) Decisions on actual ends. Objectives may not have been attained to the extent desired. Undesirable results may occur which need replanning and restructuring. In this area, evaluation is concerned with appraising continuing quality control arrangements.

(4) Decisions on actual means. The process used may differ or conflict with those intended because of conscious adjustments and improvements or a regression to habitual and inferior practices. More refinement and more control may be required.

Based on the types mentioned above, the current research is being undertaken so as to provide a basis for making decisions bordering on the first and third types of decisions. This study cannot be used as a basis for making decisions bordering on the second and fourth types for the sole reason that the curriculum being evaluated does not contain proffered means of attaining objectives intended.

The following are the possible redecisions that may result from the above four areas:

(1) affirmation of the status-quo of the operating patterns, of the goals, of the staff etc, Such affirmation confirms programme's validity and implies that the programme should continue and that cooperation and support should be given.

(2) reconsideration and possible redefinition of goals, purposes, objectives or clients served.

(3) review and alteration of means or processes used, including specific programme elements, strategies, sequences or formats.

(4) redefinition and possible reassignment of functions, duties, responsibilities and patterns of performance.

(5) review, clarification or alteration of norms, rules, policies, standards etc.

(6) change in resource allocation (budget or staff).

(7) redefinition of roles and reassignment of individuals or alterations of organizational structure.

(8) reconsideration of priorities and ordering of activities.

The above possible decisions and redecisions point to the fact that there are a variety of purposes that one can have in making an evaluation of anything and that there exist a range of different conceptions of such an activity, each of which may be perfectly suitable for some area of curriculum development. It is thus not surprising that major curriculum innovations are always accompanied by evaluation attempts. Though, in earlier curriculum development attempts, it seemed to be felt that any curriculum change must be for the better. However, experiences of later developments, particularly that which began to emerge in the early part of the '60's as teachers in diverse school situations began to make many different uses of the projects and the materials the developers presented

to them (especially in the United Kingdom and U.S.A.), led to the gradual realization that evaluation is an integral part of any curriculum development process.

Also, economic stringency have encouraged people to look more closely at innovations that might prove expensive in order to ensure that they are fully justified. Other events such as standards of achievements by pupils have led to public demand that teachers and other educationists should be made more clearly accountable to society for their work. All these imply clear monitoring of the work of the schools, particularly in the area of curriculum development, thereby increasing the felt need to evaluate the curriculum.

The differences in the purposes of evaluation have led to different types of evaluation. Hence, Kelly (1982) distinguishes between in-course and post-course evaluation. While the former are those procedures which seek to asses the work of the project as it proceeds and perhaps also to provide immediate feedback, the later are those intended to be employed when the project is completed in order to assess its overall effectiveness. The current study falls under this second category.

Scriven's (1967) way of expressing the above distinction is by contrasting summative and formative evaluation. Summative evaluation is concerned with appraisal of the work, it is a form of pay-off evaluation (Scriven, 1967) and its primary concern is to ascertain if the goals of the course have been achieved. On the other hand, formative evaluation is concerned to provide feedback (Scriven, 1967, Stenhouse, 1975) and thus a basis for course improvement, modification and future planning. On the basis of these distinctions, several attempts have been made to list the different possible types of curriculum evaluation.

Harlen (1971) listed the following four types which seem to have different purposes and functions, even though they may overlap considerably. First, evaluating the suitability of objectives of an

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educational programme, that is, attempting to assess which objectives are worthier to be achieved and more preferable to other possible and perhaps competing set of objectives. Secondly, the on-going evaluation whose chief function is helping the production of educational programme once its objectives have been accepted. Thirdly, evaluation of individual progress which can be used by teachers for purposes such as to diagnose learners ability to benefit from certain experiences, to gauge their progress, to locate their difficulties and so on. And fourthly, terminal evaluation whose most important function is to find out whether the final product does, as a whole, achieve what it set out to do, whether it does this any better than other possible materials or approaches and how extended is any effect it may have.

Perhaps, one of the most explicit attempt of listing and describing different types of evaluation is that done by Stufflebeam, Foley, Gephart, Guba, Hammond, Merriman and Provus (1971). They identified four types of evaluation. These are:

(1) Planning and developmental evaluation, undertaken to determine needs or deficiencies and to device objectives or goals to meet these needs. It facilitates decisions required at early stages of developing a new programme or of revising an existing one. It includes

   (a) defining and describing the environment (actual and desired conditions, conditions requiring adjustments).

   (b) identifying unmet needs, unused opportunities and both needed and available resources.

   (c) identifying and diagnosing sources of deficiencies in meeting needs or in using opportunities in the past (including environmental personnel and materials).

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(d) seeking to predict deficiencies in future by considering the reasonable, desirable, possible and probable relationships among inputs, processes and outcomes.

2) Input evaluation, aids in making decisions about how to use resources to attain programme goals. It does so by

(a) identifying and appraising the potentials of individuals and agencies,

(b) comparing and analyzing possible strategies for achieving goals,

(c) formulating designs for implementation,

(d) estimating immediate staff requirements, other resource requirements, costs, possible difficulties,

(e) projecting the requirements of (d) into the years ahead as the programme becomes fully operative.

(3) Process evaluation, provides continuing or periodic feedback so that those responsible for programme planning and operation can review and possibly alter earlier decisions. It does so by:

(a) detecting malfunctioning in procedures or their implementations,

(b) identifying the sources of difficulty,

(c) providing information for programme revision and improvement,

(d) appraising staff communication and adequacy in use of resources,

(e) projecting additional resource requirements not originally anticipated.

(4) Output evaluation, assess the attainment at the end of a project or at appropriate stages within it, of those goals which are self

contained and those which are preliminary to entering another stage. Output evaluation includes:

(a) identification of correspondences and discrepancies between original objectives and actual attainments,
(b) identification of unintended (either desirable or not) results and suggestions as to possible causal factors,
(c) provision of information and of suggestions for decisions to alter or replace previous planning, input and processes,
(d) provision of quality control by recycling the programme to attain unmet objectives,
(e) provision of basic information and suggestions for continuing, modifying or terminating the programme.

The current study falls under this last category. Basically, this study will attempt to compare and contrast intended and attained objectives of the curriculum in context, identify unintended results and their possible causes, provide information and suggestions that may aid decisions to alter content and process of the curriculum in context, and provision of information that will be used as a parameter for modifying the curriculum to suit anticipated future changes.

Dressel (1985) declared that evaluation must be planned in relation to the decisions to be made as well as the processes involved in making them. In such planning, it is useful that evaluators and those employing them ask these series of questions

(1) What is to be evaluated?
(2) Why is the evaluation being done?
(3) What period of time is the evaluation to cover?
(4) Who determines the goals, purposes or objectives of the programme?
(5) Who determines the criteria or standard to be used?

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(6) What criteria or standards are to be employed?

(7) What are the possible decisions or actions to be taken as a result of evaluation?

(8) What steps or procedures are to be included in the evaluation?

(9) Who will make decisions after completion of evaluation?

(10) Who will do the evaluation and how is this person related to the programme, staff and institutional administration?

(11) What preconceptions, commitments .or prejudices exist in either individuals or groups which may complicate or interfere with an objective appraisal and consequent actions?.

2.5 Evaluation Models

Decision making, which is what evaluation is essentially about, can be made more easier and effective if the decision maker is aware of the options at his/her disposal. In this regard, evaluators of today can be said to have an edge over those of yesteryears because of the different number of evaluation models they have to choose from. In the context of this discussion, a model is a theoretical plan of action that reduces each phase of the action to a step by step procedure and at the same time maintaining and showing the links between the major parts, where each component is designed to achieve specific objective (Okonkwo, 1984).

Popham (1975) classified educational evaluation models into the following broad categories;

1. Goal attainment models
2. Judgmental models
3. Decision facilitation models.

Also, the following are other evaluation models not identified by Popham

4 Systems analysis models

5 Medical models

6 Adversary models

7 Secondary models

2.5.1 Goal Attainment Models

In this model, evaluation is regarded mainly as the determination of the degree to which an instructional programme's goals are achieved. The current study draws heavily from the steps recommended by this model in the fashioning out of the research design. Popham, who identified Tyler as one of the chief proponents of this model, advocated the following steps as those basically involved in its use

(1) isolation of the aspects of the educational programme to be evaluated,

(2) definition of relevant instructional and institutional variables,

(3) specification of objectives in behavioural terms,

(4) assessment of the behaviours described in the objectives,

(5) analysis of goal attainment results. This involves analyzing the relationship between those institutional and instructional variables as they relate to the measured learner behaviour.

2.5.2 Judgmental Models

This model lays much emphasis on professional judgement. Here, a professional is given the task of conducting the evaluation. The evaluator's judgement carries much weight and determines the favourability of the work being evaluated. The focus of evaluation may be either on the process criteria or on the product criteria. If the evaluator focuses on the process criteria, this model is said to be that emphasizing

intrinsic criteria but if the focus is on the product criteria; it is that emphasising extrinsic criteria. Intrinsic criteria are associated with the object of evaluation itself or its inherent qualities while extrinsic criteria are associated with the effects of the object.

Typical examples of judgmental models emphasizing intrinsic criteria are the accreditation models employed by professional bodies, commissions and associations. For example, the Nigerian Universities Commission (N.U.C) and the National Board for Technical Education (N.B.T.E) would have to accredit any new university and polytechnic course respectively before their certificates will have national acceptance or recognition due the status it deserves. Also, there have been instances where professional bodies refuse to recognize the certificates of certain educational institutions, which is a portrayal of the kind of weight such professional bodies carry.

The procedure normally followed in judgmental models emphasizing intrinsic criteria are:

(1) the proprietor/management of an institution will first conduct an evaluation of the institution bearing in mind the laid down external criteria or principle. Their report will include such details as staff strength (in terms of numbers and qualifications) and other necessary materials and monetary resources.

(2) preparation of reports bordering on the already supplied criteria,

(3) some copies of the report are sent to the accreditation body who examines and review them,

(4) the accreditation team now visits the institution to do the actual assessment.

The above model is not used in this study because an accreditation body is not doing this evaluation and the focus is not on intrinsic criteria.

The judgmental model emphasizing extrinsic criteria has been very well dwelled upon by Scriven (1972) and Stake (1967) in the goal-free

and responsive or countenance models respectively. The focus of this study is on extrinsic criteria. Hence the adoption of the transactional model in the design of this research. It therefore become pertinent that both Scriven's goal-free and stake's transactional models be given more detailed attention than the other evaluation models discussed.

Goal-Free Model

Scriven's goal-free evaluation model focuses on the outcome of a programme. His main concern while developing this model was to reduce bias in evaluation. Bias reduction is done by making the evaluator ignorant of the curriculum developers predetermined intents. Scriven's contention is that once the evaluator knows these predetermined goals, he/she is most likely to collect data which are related to them. He further argues that if on the contrary, the evaluator is unaware of these predetermined goals, he/she will be more prone to paying attention to a wide range of programme outcomes.

It is on the basis of the above that the goal free evaluation model has been defined as the process of gathering and combining performance data with weighted set of goals or scales (Scriven, 1972). The process entails allowing the evaluator to first collect as much data as possible related both favourably and unfavourably to the programme. He/she later weighs these data with the noted needs of the society or goals of the programme to see whether there are discrepancies. The purpose therefore is to establish and justify the merit or worth of the programme. Consequently the evaluator is responsible for judging the merit of the programme for both the producers and consumers. Limitations of this model have been identified to include the creation of methodological problems arising from equating of performance on different criteria and assigning of weights to these criteria, lack of

specified methodology for assessing validity of judgment and the presence of several overlapping concepts (Worthern and Sanders, 1973).

On the basis of this limitation, particularly the absence of a specified methodology for conducting evaluation using this model, this researcher has not drawn from this model in order to accomplish the objectives of this study

Transactional Model

Stake's transactional model distinguishes between the evaluator's descriptive and judgmental acts according to the antecedents, transactions and outcomes phases of an educational programme. Stake used the word antecedents to refer to existing conditions before instruction or programme implementation, which may affect outcomes while transactions refer to the succession of engagements or activities that constitute the instruction or programme implementation. He further subdivided the descriptive acts according to intended and observed aspects, and the judgmental acts according to standards used in reaching judgment and the actual judgments themselves This model is built on the assumption that a rationale guiding the design of each educational programme exists.

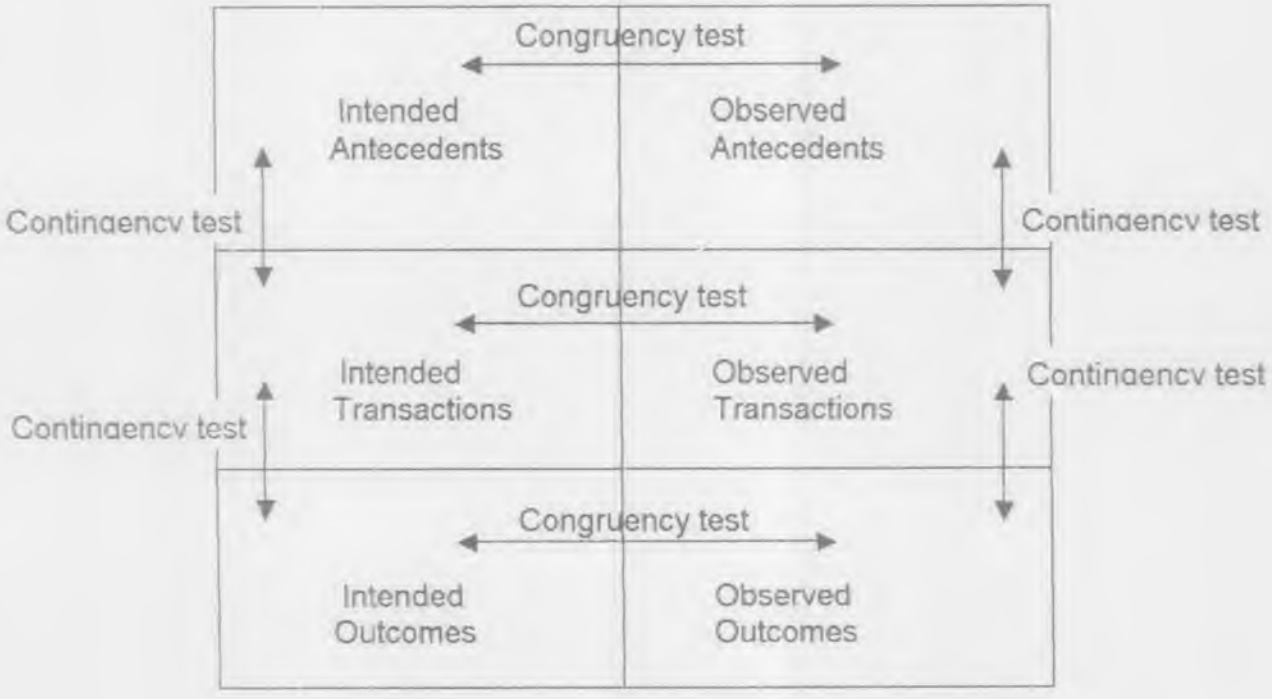
The above considerations formed the basis for defining the transactional model as that which involves describing and judging an educational programme. The purpose therefore is to describe and judge educational programmes based on a formal inquiry process. The evaluator consequently have to assume the role of a specialist concerned with collecting, processing and interpreting descriptive and judgmental data. House (1978) opined that the power of this model lies in its ability to appraise events occurring in and around the actual course/programme in context. It depends on perception and knowing as a transaction process. House (1978) further maintains that perception of individuals is

a formidable focus of study and that participation in programmes provides a basis for knowing. The process of transaction is illustrated in the figure below.

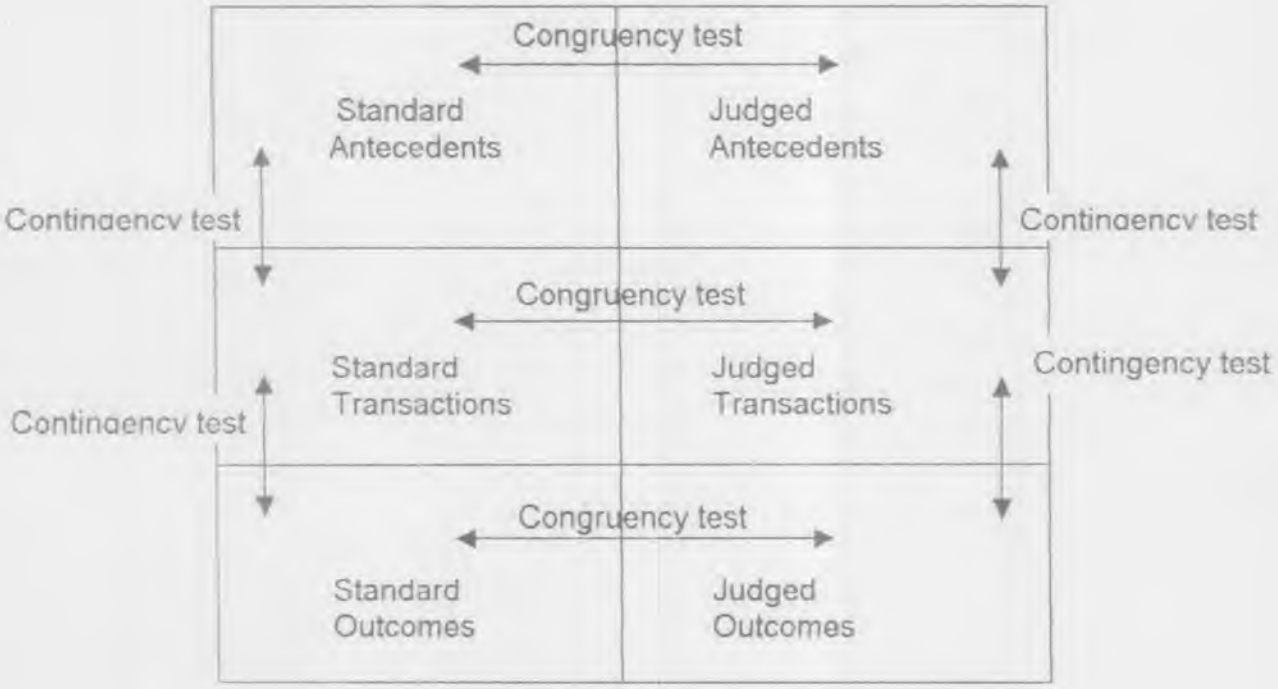
RATIONALE



DESCRIPTION MATRIX



JUDGEMENT MATRIX



Congruency test refers to identical matching between observations and intents for possible discovery of discrepancies while contingency test refers to examination of relationship between variables in the cells.

The transactional model is perhaps the only one exclusively designed for education as most others have been transferred from other fields. This model is the one adopted for the design of this research. The adequacy of the transactional model for this study is based on the fact that the data used was derived from the perception and views of participants saddled with the task of implementing the curriculum in context. In line with the tenets of this model, the operational status of the N.B.T.E polytechnic mathematics curriculum being evaluated will be reported along with views and perceptions of the respondents regarding the objectives, contents and organization of contents as well as recommended means of delivering contents (if any).

2.5.3 Decision Facilitation Models

This models main orientation is to feed decision makers with necessary information. Thus, evaluators using this model are less inclined to personally assess the worth of an educational programme. The discrepancy model and the context, input, process and product (C.I.P.P) model are two of the best exemplifications of the decision facilitation models.

The discrepancy model, propounded by Provus (1971), is based on the premise that evaluation involves the comparison of actual performance with posited standards. It has five stages, viz:

(1) **Design:** This involves taking note of the nature of the programme including its objectives, the students, staff and other resources necessary for the realization of stated objectives, the instructional activities that will enhance the attainment of the objectives.

(2) **Installation:** This involves attempting to find out whether an installed programme is meeting up with its installation plans.

(3) **Process:** This involves finding out whether the enabling objectives are being met.

(4) **Product:** This involves ascertaining whether the terminal objectives have been achieved.

(5) **Programme Comparison:** This involves cost benefit analysis of the programme (quite unlike the first four stages which are developmental in nature).

The C.I.P.P model stems from its definition of evaluation as the process of delineating, obtaining and providing useful information for judging decision alternatives (Popham, 1975). This model distinguishes between four types of educational decisions and recommends a type of evaluation corresponding to each. These educational decisions are in

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respect of planning decisions to determine objectives, structuring decisions to design of instructional procedure, implementing decisions to use, monitor and improve these procedures and recycling decisions to judge and react to the outcomes produced by these procedures. The respective recommended forms of evaluation with regards to these educational decisions are context, input, process and product evaluation.

2.5.4 Systems Analysis Model

The systems analysis model is a tool executive's employ for making decisions based on incomplete information. It is designed specifically to help decision-makers arrive at optimum choice among possible alternatives (Anderson, Ball and Murphy, 1976). This model entails the process of explicitly specifying the number of ways of achieving the stated objectives of a set of numerous elements that share common purpose and involve interactions and interdependence (Anderson et al, 1976). The scope, nature and objectives of the current study do not warrant the use of this model. Consequently, this model has no direct bearing on the current study.

2.5.5 Medical Model

The medical model arose in response to the need for a more complex approach than the engineering model. It explicitly recognizes that prescriptions for treatments (i.e. curriculum content) and the evaluation of their effectiveness should take into account-reported symptoms and other characteristics of the organism as well as its ecology. The engineering model simply involves comparison of the average gain for different groups, some of which might have benefited

from the programme being evaluated. This model, which focuses on input - output differences only, provides information for developing or modifying a programme. In order to address this shortcoming, the medical model monitors possible side effects of any treatment given. This model, which places much emphasis on the importance of comparative longitudinal data and the need for multivariate analysis procedure, cannot be fully adopted to suit the current study. This is principally due to the scope of the study.

2.5.6 Adversary Model

The adversary model borrows heavily from the "classic confrontation technique of formal debate" (Popham, 1975). Proponents of this model are of the view that a better job will be done if two highly partisan groups are asked to gather and present data in a conflict - type setting than if they engage in the same job in a non-competitive setting. Anderson et al (1976) maintained that the underlying assumption for the above assertion is that the evidence thus provided will have been thoroughly sifted so that unwitting biases and hidden assumptions will be expunged for fear of exposure by the decision makers. The use of this model entails the following procedures:

(1) Programme identification

(2) Programme study

(3) Presentation of programme advantages and disadvantages by the two opposing groups.

(4) Report study by panel of decision-makers.

(5) Passing of judgement based on the criteria of value orientation, scope and sequence of programme, methods and materials prescribed, characteristic of learners and teachers, determination of

the extent the programme provides for self evaluation and the conduciveness for the programme of these prevailing conditions.

2.5.7 Secondary Model

The secondary model sometimes referred to as the "meta-evaluation" occurs above and beyond the initial or primary evaluation (Anderson et al, 1976). This model may be considered as a critical review or reanalysis of the data of the primary evaluation. This may be bordering on the accuracy of the results and conclusions of the primary evaluation.

The last two evaluation models discussed can not be adopted either fully or partially for the current study. With respect to the adversary model, this is because the current research does not involve any competitive process. As for the secondary model, the current research being the first known to the researcher since the development of the NBTE Mathematics curriculum obviously has no primary research to use. These reasons justify the non-adoption of any of these two models in the current research.

2.6 Mathematical Studies In Educational Technology

Rosembloom (1983) in Kyeleve (1988) asserted that many leading mathematicians like Felix Klein, John Perry, E.H. Moore and Morris Khine have advocated for the teaching of the applications of mathematics for a long time. Rosembloom observed that the situation was still unimpressive and highly lamentable in American schools. Six years later, Kyeleve observed that this situation is very identical to what is obtained in

Nigerian technical colleges where most of the mathematics text books in use hardly contain any vocational or trade questions.

The above situation is similar to what obtains in Nigerian Polytechnics prior to the development of the current N.B.T.E. mathematics curriculum for Nigerian polytechnics. The development of this curriculum has led to authorship of textbooks that specifically cater for this need. This is in agreement with Rosembloom's suggestion that the applications of mathematics be introduced and incorporated into the existing curriculum. Hence Kyeleve noted that mathematical ideals and their applications could be taught in close proximity. Therefore this study will attempt to assess the extent to which applications of mathematics and mathematical ideals are reflected in current polytechnic mathematics curriculum.

In Fitzgerald's (1976) study of two industrial training schools' contents of their engineering craftsmen and technicians mathematics syllabus, it was found that certain topics were likely to be met by apprentices with desirable considerable competence. In this study, 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. The result showed that topics such as fractions and equations are more likely to be met by apprentices. However, acquaintance with many other items were necessary but particular application of these mathematical ideas to workshop practice was not expected initially.

The implication of this study as noted by Fitzgerald, is that all is not well with the teaching of mathematics for industrial workers. With the development of the present mathematics curriculum for polytechnics, can this situation still be said to hold? Hence, the current study is designed to

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assess, among other things, the relevance of the contents of the current polytechnic mathematics curriculum to the employment needs of the students. Based on the implications of his study, Rosembloom suggested a series of graded competence tests, starting at a very low level with high pass marks, so that a pass clearly indicate competence in an identifiable set of items. The evaluation of such a test will clearly be based on the objective model. Another study undertaken by Bereson and Robinson (1983) reported in Kyeleve (1988), assessed the mathematics requirement for Israeli technicians and practical engineers. The study focused mainly on electronics, electricity and control systems, which were examined in the light of their mathematical needs while both in college and on the job. The study also investigated the influence of technical advances such as computers on mathematics employed by technicians and practical engineers in the industry and changes in mathematics curriculum in colleges of technology as a result of increasing technological sophistication of local industry among others.

In the above study, responsive evaluation technique, text book analysis and interviews with eleven senior personnel in eleven leading Israeli electrical/electronic industries were utilized. The results revealed that

(1) the mathematical tools at the disposal of Israeli technicians and practical engineers is adequate for their general day to day needs. However, the ability to apply mathematical knowledge learned in colleges or high schools was 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 allotted to logarithms and trigonometric computations, exploitations of hand calculators and an earlier introduction of logic, matrices, determinants, bolean algebra and differential equations,

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

2.7 Related Evaluation Studies

There exists a wide range of possible approaches to evaluation of educational provisions for different levels and systems worldwide. However, reports on the status of the nature and extent of programme evaluation specifically bordering on polytechnic mathematics curriculum are generally scarce. Therefore, this section addresses issues, which concern the evaluation of educational provisions in some selected countries where questions of quality control and accountability have become prominent.

One of such experiences is an elaborate system of internal evaluation, which exists at the free university, Amsterdam (Drenth, Van Os and Bernaert, 1989). This system aims at quality improvement of education through internal evaluation. It is based on the educational and psychological point of view that self-evaluation resulting from self-motivation is and remains the best condition for improvement. This system, AMOS (in Dutch: Analyze Model Voor het Onderwijs Op Studierich tingsnivia) comprises a blue print of evaluation propositions concerning academic education including the following components:

(1) study progress in undergraduate and graduate phases specified according to year and discipline,
(2) regulations concerning final tests and examinations,
(3) control and adoption of teaching process on the basis of information regarding study progress,
(4) study requirements,
(5) guidance of students and care paid to teaching (at course level).

Here, the order is explicitly from global (success rate at termination of the training period) to specific (didactic qualities of the teachers). This model consists of well-defined signals upon which more detailed analysis could be conducted. The first important signaling point is "propaedause" examination after one year of study. An experimental normative flow chart is set up for the first year of studentship. This chart comprised the following elements:

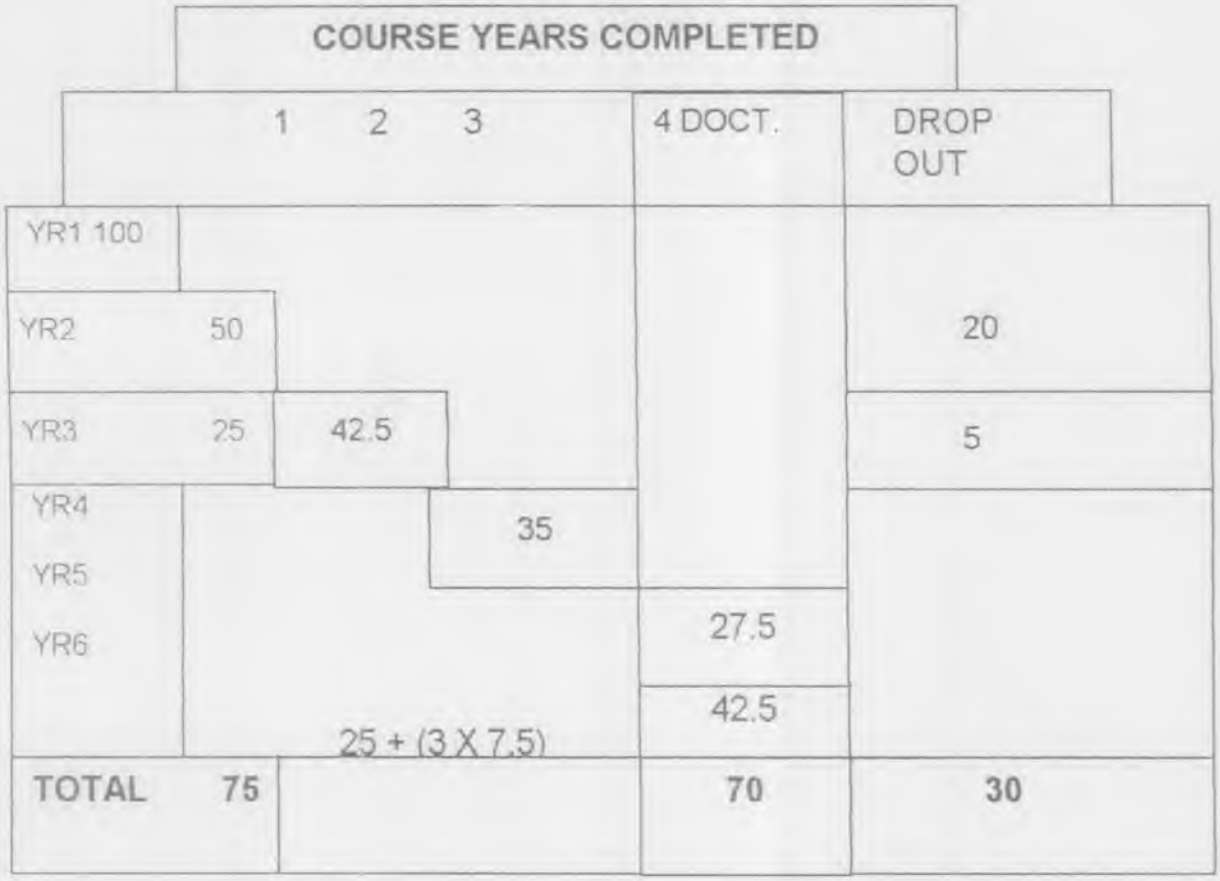
(1) the starting point is 100% of students who registered for the first time in the faculty in question,

(2) it is assumed that at the end of the first course year, 50% will pass the examination - so 50% forms the first guideline ciphers,

(3) it is assumed that 50% who completed the first phase are also able to continue and complete the doctoral programme without delays. This expectation is quantified in the table by assuming per doctoral year a maximum delay of 7.5%, so that ultimately 27.5% (the majority of 50%) will complete the doctoral phase within the specified course time,

(4) officially, the maximum time allowed for the first phase is two years. A guideline ratio of 75% is set: 50% passing at first attempt, 25% who need an extra year. In the doctoral phase, it is assumed that this 25% (who started after one year delay) plus the 3 x 7.5% who have a delayed doctoral study, almost all succeed in getting their doctorate degree within maximally allowed time (which is six years). It is assumed that only 5% will not succeed, which results in 42.5% success, be it delayed,

(5) the total success rate will therefore be 70%: 25% succeeds within the four year period. An additional 42.5% succeeds in the following two years.



AMOS FLOW CHART OF STUDY PROGRESS

(The percentages in the diagonal i.e. 42.5%, 35% and 27.5% form the guideline ciphers for the study progress in the three year doctoral course).

Drenth et. al quickly remarked that in cases where the actual study progress deviates from guideline ciphers given in the scheme, further analysis should be carried out. So far as this scheme focuses mainly on programme evaluation as a whole, it still has great implication for the current study. It is this researcher's opinion that the scheme can be adopted with slight modifications for the purpose of course evaluation, which is the main concern of the present study.

This can be particularly useful to the Nigerian higher education system where students are allowed to carry over failed courses due to the semester system in operation. It is observed from available literature that

perhaps no such evaluation model as the AMOS is available at the moment in any Nigerian tertiary institution.

The absence of any developed scheme for course evaluation in Nigeria does not imply the same all over the world. For example Talbot and Bordage (1986) reported the existence of a developed method of course evaluation in Canada. This method, which is based on small group discussion, was used to evaluate courses at the faculty of medicine of Laval University. The method uses students perception of the courses. The object was to obtain information directly from the students rather than through questionnaires prepared by professors.

In trying to obtain these informations, the researchers chose the nominal group process (Dolbeeq, Van de Ven et Collaborateurs, 1975; Aubin, 1975) because it met the conditions under which the discussions were to be held. Two methods were used to answer their research questions, viz:

(1) method of course evaluation based on small group discussion.
(2) the questionnaire prepared by teachers responsible for the course.

The first method is based on students perception of the strength and weaknesses of the course. The second is based on students perception as expressed on a Likert scale of the aspects of the course defined by the teachers. Using Dufresne's (1981) item bank for course evaluation, seven aspects of the course were targeted as aspects of evaluation. These are objectives, content, texts, required reading and course notes, teaching methods and self learning materials, methods of formative and summative evaluation, miscellaneous aspects and recommendations. These different aspects served as reference both for the preparation of questionnaires and for classification of observations obtained from the students in the small groups.

The evaluation of a course by "directed small group discussion" proceeded in three steps, viz:

(1) the formulation of the assessment by each student. Here, each student writes his own impression of the course on cards (8cm x 12cm). Each card contains only one observation or assessment corresponding to a course object of evaluation. This step ends when every student has finished writing his/her observation,

(2) the pooling of the assessment. Here, the group leader just asks the students to classify their observations according to the seven categories mentioned earlier. A student then states one observation as noted on the first card. This procedure is repeated until all the cards have been read; however once an observation has already been made, it is not repeated by subsequent students. Each observation is given an order number which the student must note on his card. No discussions or comments are allowed during this second stage,

(3) the establishment, by the group, of a level for agreement for each assessment. This third step is in two parts; making revisions or additions to the observations noted and voting by the group on all these revisions or litigations. At the end of the third step the discussion group leader collects the cards according to category names and order number. These observations are then typed and transmitted in full to the person responsible for the course except that the names of the teachers are given in a code which is known only to the person responsible for the course and, where appropriate, the teacher in question.

In order to determine just how much each teacher expected from the evaluation of his/her course using the method of evaluation by questionnaire, each teacher drafted his/her own questionnaire. To prepare their questionnaires, teachers used an item bank for course

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evaluation containing about 100 items relating to various aspects of a course (Dufresne, 1981). Each student receives the questionnaire accompanied by a computerized answer sheet. At the end of the written questionnaire, there is a separate sheet on which students can make suggestions or recommendations for improving the course.

Another method of course evaluation similar to that described above is reported to be in existence at Cape Town University, South Africa. This method, known as the "list format approach to diagnostic course evaluation", is based on the following premises:

(1) that no evaluation of teaching can be carried outside the context of the course in which that teaching has occurred,

(2) that ownership of (and responsibility for) an evaluation exercise should reside with the person responsible for running the course,

(3) that any evaluation of a course should be a potentially formative exercise, in the sense that the findings should be capable of being used in the diagnosis and treatment of course difficulties,

(4) that the students should be consulted and have a valuable contribution to make,

(5) that students perceptions should not, however be regarded as the final word in the assessment of a course,

(6) that if the process of data gathering needs to be carried out on a large scale, it should follow as closely as possible the natural evaluative strategy of simply asking students "How is it going?" and then questioning them more closely about the problem areas at which they hint.

The developer of the above method, Pastoll (1985) observed that the practice of evaluating university courses with help of information gathered from students is widespread and that a necessary condition for this type of evaluation to lead to genuine improvement is that the

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evaluative criteria employed by the students be reconciled by those employed by the teacher who owns the course. This method is therefore based on the assumption that students perceptions of their context are valid.

The list format procedure consists of three stages. The first being to identify those areas in which students have experienced problems. To accomplish this, students fill in a three section questionnaire. The first section consists of a list of course elements to which they must respond.

For example.

SECTION 1

Read the list of items and respond to each by writing an appropriate numeral in the box beside it.

1 = I like the item or thought it good

2 = I found it merely satisfactory

3 = I experience difficulty with it

(a "difficulty" can be anything which made your learning experience less than satisfactory).

1. The amount of material to be learned --------
2. The level at which the course was pitched --------
3. Relevance of material to my own needs --------
4. The amount I learnt from lectures --------
5. .....

The second section of the questionnaire calls upon the students to probe deeper, using the responses they had already made as a guide.

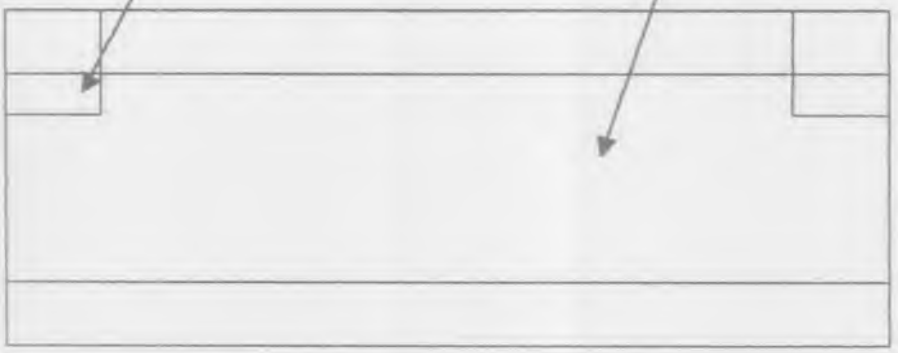
For example

SECTION 2

Have you written any 3's in section 1, indicating a problem area? If so, (a) select a maximum of three - those which caused the greatest difficulties, and (b) for each one of these fill in one division below, as follows.

(1) Write here the item number from Section 1

(2) Describe the difficulty here, plus a remedy if you have one.



Three of such spaces are provided)

In the third section, students look at the written problem descriptions they have provided and classify the seriousness of each one according to a given code.

For example.

SECTION 3

Classify the seriousness of each difficulty you described in Section 2 by writing one of the following letters in the spaces to the right of your written description.

A = a major problem to me. I found it seriously impeded my ability to benefit from the course.

B = a substantial problem, but one which I was able to overcome.

C = a minor problem, but life would be easier without it.

In an attempt to justify the contents of the three sections, Pastoll asserts that the list of course items provided in section one is an effective method of prompting students to think about all the features of the course that the evaluator wishes to investigate. The second section serves to identify the nature of the more prominent difficulties that the students perceive themselves to be experiencing. The A, B or C classifications assist the evaluator to establish some indications of whether any given problem actually affects enough people severely enough to be a real point of concern.

For comparative purposes, a numerical index based on the weighted average of the number of A's, B's and C's associated with any given course element was used. This index, called the "Apparent Problem Magnitude (APM), is simply a number from 0 to 3 indicating how serious the class as a whole views a reported problem. The APM course index for a given course element will assume a value of 0.00 in the case where no difficulty have been reported. The maximum APM value would be 3.00 in the case where every single respondent not only described a

problem in writing, but also classified it a major difficulty. These APM indices may be ranked and any item whose APM is above a chosen value may be earmarked for further investigation.

The analysis of responses results in the establishment of a finite agenda consisting of only those problems which all felt to affect learning (by the whole class) seriously enough to warrant further substantiation. This finite agenda is discussed at a meeting between students and teachers. The meeting itself, which is to be attended by some of the students and all the faculty members responsible for the course, constitute the most important part of the entire procedure. The purpose of the meeting is to discuss each apparent problem areas, as evidenced by the APM indices. Each issue may be substantiated and classified by the views of the groups. During such meetings, wherever problems are conceded to exist, those present should attempt to provide solutions and make definite statements of intent to implement those solutions. To illustrate how this approach works in practice, Pastoll reported that by 1985 when the method was being reported, it had already been successfully used in the formative evaluation of at least twenty five courses in seven separate faculties at the university of Cape Town, South Africa. And, it was also being used at two other South African Universities.

The findings of two successive evaluation was quoted to indicate the extent of course improvement that occurred as a result of applying this procedure. A particular course (Pseudonym: "Medicourse1") of the faculty of Medicine received strong criticisms from the study body in the 1983 evaluation. Following the staff-student course evaluation meeting a number of significant changes were made to the course. A year later, the course was again evaluated with help of identical instrument to the one used in 1983. Twenty three course elements were listed in this instrument. A major improvement (i.e. reduction) was seen in the APM

value of all five course elements that had ranked as the greatest sources of difficulty in 1983. Of the twenty three elements, only two showed an increase (i.e. worsening) in APM value between 1983 and 1984. Neither of these two were significant problem areas in either year.

Pastoll thus concluded that these results, though, are not direct evidence of the actual teaching changes which occurred, they do reflect real reductions in apparent extent of learning difficulties encountered on the course. The last two studies and programme evaluation reports just described has considerable implication for the current study. These are in terms of methodology and parameters used in determining the curriculum aspects focused on during data gathering phase.

In Nigeria, literature encountered did not reveal the existence of any developed specific programme evaluation approach such as the two cases outlined above. However, various programme evaluation studies have been conducted at various levels and in various courses. It is to some these studies that we now have to turn towards in order to establish what has so far been done in relation to this particular study.

Brown (1978) evaluated attainment of science objectives in terms of the children's ability to practice process skills. He also measured the children's interest, active participation and understanding of the lessons, as well as the availability of materials and ease of preparing and teaching the lessons for teachers. A total of 84 science teachers and five hundred and seventy six students were drawn from Northern Nigeria. Questionnaires were used to gather data from the teachers while children were tested to measure the attainment of process skills. The findings showed that the teachers rated the programme as successful in terms of all the measured criteria. It was also noted that some teachers were not teaching science because of lack of science competency and a shortage of science materials.

A comparison of the children tested from the Primary Education Improvement Programme (PEIP) schools and non - PEIP schools indicated significant differences in favour of children in PEIP schools after one year, but not after two years and that girls seemed to profit more than the boys in terms of an improved ability to practice process skills. Recommendations included proper training of PEIP teachers and supply of adequate science materials to the schools.

Jegede (1981) evaluated the Nigerian Integrated Science Project. The sample consisted of 1893 form two students from 14 secondary schools and 423 integrated science teachers drawn from all over the country. The instruments used were questionnaires for teachers, assessment test, attitude scale test, readability formulae and anecdotal reports. The focus of the study was the assessment of the achievement of the project's objectives as expressed by the teachers as well as the performance in, and attitude towards integrated science by the students. The findings showed that the integrated science teachers are not favourably disposed towards the project due to lack of appropriate training, the cognitive objectives achieved were below expectations but majority of the students have developed scientific attitude through the activities of National Integrated Science Project (NISP). There was a significant negative correlation between attitude to science and achievement in integrated science ($P < 0.01$).

Location of school, sex, socio-economic background were found to be correlates of achievement in, and attitude towards integrated science. The findings also showed that majority of the students found NISP books very difficult to understand and the readability indices of the books indicated that they are too advanced for the audience for whom they were written.

Akolo (1982) evaluated the adequacy of the Universal Primary Education (UPE) Teachers' Education Curriculum materials in arts and

crafts in Teachers' Colleges in ten states of Nigeria. The major instrument for the study was questionnaires for students and teachers of the selected programmes. A total of 1529 students and thirteen teachers participated. The study involved

(1) documentation of information on the evolution of the curriculum materials,
(2) logical analysis of the general objectives of the materials with regards to theories of art education,
(3) determination of the internal coherence of the materials, and
(4) empirical analysis to determine if the material was usable, whether it helped achieve stated objectives and whether the setting was supportive.

The findings indicated that

(1) students attitudes were very weak in items that express negative propositions and strong on positive ones,
(2) teachers qualification and experience correlates with teachers score on attitude scales,
(3) the materials omitted the critical aspect of art education,
(4) the setting was becoming supportive, and
(5) most of the stated objectives were reportedly achieved.

It was recommended that a future study will be needed to assess the students learning outcomes against classroom interactions. Modifications and more efficient dissemination of the UPE materials (for provision for art criticisms) should be made. Both pre-service and in-service training were strongly recommended.

Okonkwo (1984) conducted a need assessment study of Bachelor of education (B.Ed) Language Arts programme, of Ahmadu Bello University, Zaria. The purpose was to ascertain whether the programme is addressing the needs of the clientele or not and to make

recommendations. The main focus was on the academic and professional needs of the teachers, students and graduates of the programme.

A total of one hundred and seventy six subjects were used for the study and the instrument consisted of three editions of questionnaires for the three sub-groups. The results showed that the subjects perceived most items to be of high importance for teachers of Test of English as a Second Language (TESL). Areas perceived as highly important for the trainees include subject matters and experiences in knowledge, skills and teaching practice. Most subject areas were perceived to be moderately covered. Based on the findings, it was recommended that the programme be reviewed to address specific needs.

Literature search revealed that educators in Nigeria have, for sometimes now, been concerned with evaluation of the fundamental subject matter areas taught in primary and secondary schools. It is from this point of consideration that the current study derives much of its elixir from. Reviewing the status of curriculum evaluation in Nigeria, Urevbu (1983) contends that a need exists not only to find out the present status of curriculum evaluation but also to provide an adequate framework for evaluating a curriculum programme of any subject matter area. It is hoped that the current study would be able to achieve that much in relation to Nigerian Polytechnic mathematics.

All the studies reviewed above have emphasized the need for more evaluative researches and provided some insight for the present study. In particular, the methodology adopted by Kyeleve (1988), Okonkwo (1984), Akolo (1982) and Jegede (1981) have been combined to fashion out some part of the data gathering procedure adopted for the present study. Therefore some of their instruments were modified in line with the peculiarities and status of the curriculum and level of education being focused upon in the current study.

2.8 Summary

This chapter has attempted to review the essential issues concerning curriculum studies and evaluation in its many ramifications. The review was intentionally presented from two perspectives, namely: the theoretical framework and previous studies perspectives. The chapter begins with a discussion on the nature and factors to be considered during curriculum planning with a view to articulating those salient features of a curriculum that should be made amenable to evaluation attempts.

In this regard, it was pointed out that the four major factors which usually necessitated curriculum change are societal needs, educational aims and objectives, advent of new knowledge and the result of evaluation. Consequently, it was made clear that these four factors always form the basis for evaluation and that during curriculum evaluation, any or a combination of sum of the following factors may be the focus of the evaluator: educational objectives, contents, procedures and evaluation. In relation to this study, the focus is on contents.

Different means of effecting curriculum change were discussed. In this wise, then role of the teacher was fully entrenched. This lend credence to the justification to the use of teachers teaching a course to evaluate same. In discussing curriculum evaluation models and their relevance to the current study it was shown how of the different curriculum evaluation models reviewed, only the stake's transactional model adopted for this research fits the purpose and design of the current study.

Finally, a review of mathematical studies in educational technology and related curriculum evaluation studies were presented in a manner as to set the current study into perspective. This helped in establishing the fact that curriculum evaluation studies should be a continuous process.

Consequently the currency and relevancy of the current study towards quality improvement of the Nigerian education system in particular becomes established.

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Chapter 3

RESEARCH METHODOLOGY

3.0 Introduction

In this chapter, the operational blueprint employed to accomplish the objectives of this study is described. The presentation is made in accordance with the underlisted headings.

(1) Research design
(2) Population
(3) Sample and sampling procedure
(4) Instrumentation
(5) Method of data collection
(6) Data analysis technique
(7) Pilot Study

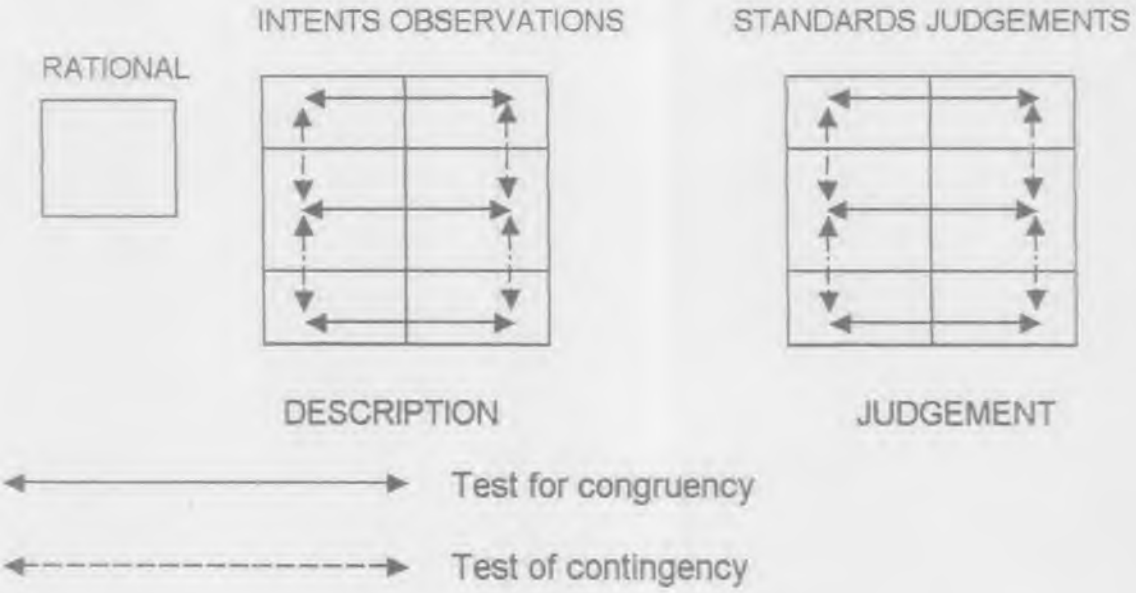
3.1 Research Design

This study, designed to evaluate the N.B.T.E mathematics curriculum for Nigerian polytechnics, adopted a modified version of the Stake's (1967) transactional model of evaluation. A combination of the responsive and institutional self – study approaches (ASCD, 1983) were used to make the adapted model fit this research. These two approaches are in agreement with the transactional model.

The institutional self – study using staff members is one of Stake's nine approaches to educational evaluation (ASCD, 1983). In addition to

the purpose for curriculum content evaluation, this approach has the potential to review and increase effectiveness among staff.

The data-gathering model of curriculum evaluation used is presented below. This is a modified version of the Stake's (1967) model discussed in 2.5.2.



The rational indicates the philosophic background and basic purpose of the course. This cell provides the basis for evaluation of intents and standards, which in turn provide the basis for appraising observations and arriving at judgements respectively. It is in line with this that the description matrix has been divided into intents and observations, while the judgement matrix is divided into standards and judgements. Here, intents and observations refer to the parameters to be used in arriving at conclusion's while judgement refers to the actual conclusions arrived at.

Each cell under intents as well as observations addresses the course objectives, content of study and organization of the curriculum content being evaluated. Thus, for a particular course unit, the description matrix illustrates the congruency test carried out between

(i) Intended objectives and observation of what was actually achieved,

(ii) Intended learning experiences and observations of what learning experiences learners are actually exposed to,

(iii) The organization of these learning experiences and what actually happens in the classroom.

Also, the description matrix illustrates the contingency test carried out between

(i) Intended objectives and content,

(ii) Intended study content and organization of the contents,

(iii) Observed achieved objectives and study content covered,

(iv) Observed study content covered and manner in which content was organized during the teaching period.

As for the judgement matrix, the test for congruency and contingency will be carried out between the standards to be used for reaching judgements and the actual judgements arrived at. Also, for any particular course unit, both the contingency and congruency test was for:

(i) Course objectives

(ii) Content of study

(iii) Organization of the study content.

The following steps were used to implement the design of this study

(1) determination of the major focus of evaluation. These include the determination of:

  (i) the extent to which the curriculum objectives are tenable.

  (ii) the relevance of curriculum objectives to current and future needs of students.

  (iii) the adequacy of curriculum contents to Nigeria's present and future technological needs.

(2) determination of source of data i.e the lecturers.

(3) determination of nature of data ie. perception and views of participants.

(4) development of research instrument, its validation and reliability estimation.

(5) determination of data gathering technique.

(6) administration of research instrument.

(7) analysis of data collected.

(8) report of findings and comparison of findings with other studies.

(9) drawing of generalizations and making of recommendations.

3.2 Population

The population for this study comprises all lecturers teaching mathematics and engineering subjects in the four institutions generally referred to as the first generation polytechnic i.e. Yaba College of Technology, Kaduna Polytechnic, Institute of Management and Technology and Auchi Polytechnic. As at the time this research was conducted, there were 125 lecturers teaching mathematics and 355 lecturers teaching engineering subjects in the institutions.

All mathematics lecturers belong to the statistics/mathematics departments. Those teaching engineering subjects belong to one of the following engineering departments: civil, mechanical, chemical, agricultural mechanization, electrical/electronic, and mineral resources. A common feature of this population is that each member is in one way or the other involved with the teaching of at least one of the levels in the ND or HND programmes in engineering.

The suitability of this population for this study is based on the deep rooted support from literature on curriculum evaluation (Dressel, 1985; Worthen and Sanders, 1973; Fitzgerald, 1976; UNESCO, 1974) and later evaluation studies (Kyeleve, 1988; Drenth et al, 1989; Afe, 1991; Agwai, 1991; Gulma, 1999) on the use of teachers teaching a course to evaluate

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same. Table 3.1 gives a summary of the distribution of the population by both institution and area of specialization.

Table 3.1 Distribution of study population by both institutions and area of specialization.

Institutions	Area of Specialization	
	Mathematics	Engineering
Yaba College of Technology	43	85
Kaduna Polytechnic	65	163
Institute of Management and Technology	11	54
Auchi Polytechnic	06	53
Total	125	355

3.3 Sample and sampling procedure

The sample used was 214. This sample size was derived from Morgan and Krejcie's (1970) table of recommended sample size for a population such as that targeted in this study. The proportional stratified random sampling technique (Fergusion, 1981) was used to arrive at the distribution of the samples. This technique entails that members of the sample, which were randomly drawn, were such that the proportions of the various strata in the sample are the same as the proportions in corresponding strata of the population. Table 3.2 below gives details of the distribution of the sample by both institutions and area of specialization.

TABLE 3.2: Distribution of sample by both institutions and area of specialization.

INSTITUTIONS	AREA OF SPECIALIZATION	
	Mathematics	Engineering
Yaba College of Technology	19	38
Kaduna Polytechnic	29	72
Institute of Management and Technology	05	24
Auchi Polytechnic	03	24
TOTAL	**56**	**158**

3.4 Instrumentation

The "Polytechnic Mathematics Curriculum Evaluation Instrument" (PMCEI) is the sole instrument used for this study. The major reason that necessitated the development of this instrument is that non of the current curriculum evaluation instruments known to this researcher clearly fits the design of this study. In addition, non of the existing instruments available to the researcher has been locally validated to meet the social and psychological disposition of the population targeted in this study.

In the construction of the PMCEI, extensive review of literature was made to ensure that all the fundamental concerns of a truly reliable and valid curriculum evaluation instrument is taken into consideration and appropriately addressed. Consequently, certain items were patterned after existing related instruments. However, great care was taken to

ensure that items in the research instrument are strongly related to the objectives of the present study.

The PMCEI, designed to conduct a post-implementation evaluation of the N.B.T.E polytechnics mathematics curriculum, is made up of four section. Section one seeks information on the demographic and personal data of respondents. This information was used to answer the first research question. It also provided the basis for answering the remaining five research questions and testing of the four research hypotheses. In other words the demographic data was used for classification purposes in then answering of research questions and hypotheses testing.

Section two seeks information bordering on the perception and views of respondents on each of the following six dimensions of a curricular entity.

1. The general objectives of each course unit
2. Balance and scope of contents of each course unit
3. Reasonability of the organizational structure of the contents of each course unit
4. Applicability of each course unit to area of specialization.
5. Relevance of instructional objectives
6. Relevance of contents

This section is a 110 item-four point Likert type instrument. Each statement of every item ends with four options that make the statement completely favourable, favourable, fairly favourable or not favourable to the curriculum aspect being evaluated. The respondent is to choose one option in each item. Options making items completely favourable were awarded four points, favourable three points, fairly favourable two points and not favourable one point.

The first, second, third, and fourth dimensions of a curricular entity listed above were each assessed by seven items while the fifth and sixth were each assessed by 41 items. Responses to this section were used

to answer research questions two, three, four and five. They were also used to test the four research hypothesis.

The third and fourth sections of the PMCEI are checklists designed and used for the assessment of the adequacy of learning facilities and mathematics lecturers in the institutions covered during the research. This information was used in reporting the current situation of facilities and teaching personnel available for the proper implementation of the curriculum content.

3.4.1 Validity and Reliability of research instrument

Three main steps were taken to ensure high reliability and validity of the research instrument. Firstly, many items in the research instruments were deliberately patterned after existing instruments with high reliability and validity coefficients. For example, the Badmus' (1985) Mathematics Curriculum Evaluation Questionnaire (MCEQ) used to study the perception of teachers for the "Junior School Mathematics Curriculum" (JSMC), has a reliability coefficient, alpha, of 0.89 which is an estimate of its internal consistency.

Secondly, the draft of the PMCEI was given to three experts in the field of mathematics curriculum evaluation to face validate. Thirdly, the draft was divided into two halves, to pave way for pilot testing. This was used to establish both measures of reliability and validity coefficient through the finding of

1. Equivalent forms correlation coefficients
2. Estimate of interrater reliability
3. Stand error of measurement

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Equivalent form correlation coefficient

In order to establish the fact that the two tests used during pilot study were capable of measuring what they were designed to measure, the parallel form reliability coefficients shown in table 3.3 below were obtained for the two groups of respondents.

TABLE 3.3: Summary of parallel form reliability coefficient for the research Instrument (Instruments A and B compared).

Respondents	r-Cal	r_{11}-Cal	Df	Critical value	Level of sig.	Remark
Mathematics Lecturers	.579	.73	29	.355	.05	Significant
Engineering Courses Lecturers	.609	.76	29	.355	.05	Significant

N = 30

In the table, r_{11} represents the parallel or equivalent form reliability calculated using

$$r_{11} = \frac{2\, r_{½½}}{1 + r_{½½}}$$

where r_{11} is the estimated reliability of the full length of the test and $r = r_{½½}$ is the actual correlation between two half length tests. *(Source: Thorndike and Hagen, 1977).*

As could be seen from the table, the tests are significantly correlated. This means that the research instrument is a highly reliable instrument suitable for both mathematics and engineering subjects lecturers in the evaluation of the N.B.T.E polytechnics mathematics curriculum.

Estimate of Interrater Reliability

To establish the interrater reliability, after all the questionnaires completed have been scored by the researcher, they were given to two specialist in mathematics education to judge interscorer agreement in scoring the questionnaire. Their judgements were given in terms of the overall percentage agreement with the original scores obtained by the researcher. Both judges gave 98% and 97%.

Standard Error of Measurement

The third effort at establishing reliability estimate for the research instrument was by calculating the standard error of measurement for the two sets of respondents. These are shown in table 3.4 below.

TABLE 3.4: Summary of standard error of measurement for the research instrument.

RESPONDENTS	S E M	
	INSTRUMENT A	INSTRUMENT B
Mathematics Lecturers	2.93	2.60
Engineering Courses Lecturers	2.03	1.80

Where SEM is the standard error of measurement and was calculated using SEM = SD $\sqrt{(1 - r)}$, where

SD = standard deviation of the particular test

r = the calculated reliability coefficient

(Source: Gay, 1992)

Since SEM is an estimate of how often one can expect errors of a given size and that low values of it indicates high reliability for a given test (Gay, 1992) it is interesting to note that the research instrument has relatively low estimates of SEM. Therefore, with the highest SEM at 2.93,

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it follows that the highest error one can expect with the research instrument is just about three scores only.

3.5 Method of Data Collection

Sections one and two of the PMCEI, which are the questionnaire part of the research instrument, was personally administered by the researcher with the help of one research assistant in each of the institutions used. A period of one week was allowed between the administration and collected of each questionnaire. Sections three and four of the PMCEI, which are checklists for the assessment of the adequacy of learning facilities and mathematics lecturers respectively, was personally completed by the researcher after due investigations at the institutions covered.

3.6 Data analysis technique

The data collected was subjected to both descriptive and statistical analysis. The information on the demographic items was tabulated using frequencies and percentages. They were used to describe the characteristics of the two groups of lecturers used as the study samples. The 95% confidence level i.e. an alpha level of 0.05 was used in all statistical analyses throughout the study. The Chi-square statistic was employed to test the first and fourth null hypothesis as applicable to the one factor experimental design with repeated measurements. In this type of experimental design, N subjects were measured under K conditions or treatments with respect to one experimental factor or variable.

Applying the above test to the first null hypothesis. It means that the 56 mathematics lecturers are the subjects (i.e N = 56) and the seven

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tems meant for the assessment of general objectives of the curriculum epresents the conditions or treatment (i.e K = 7) while the experimental actor or variable under consideration is the attainability of the curriculum's general objectives.

As for the fourth null hypothesis, the 158 engineering courses ecturers are the subjects (i.e N = 158) and the seven items assessing the applicability of the curriculum contents to students' areas of specialization represents the experimental factor or variable under consideration.

The second and third null hypotheses were tested by means of the t-test statistic using Fisher's t for testing of difference between uncorrelated means (Guilford and Fruchter, 1978). In these two cases, the mean opinion scores of the two groups of lecturers regarding the relevance of instructional objectives to contents of the curriculum and the relevance of the curriculum to students' areas of specialization are the two respective sample means tested.

3.7 Pilot Study

The pilot study was conducted on a sample of thirty mathematics and thirty engineering subjects/courses lecturers in Kaduna Polytechnic. The first test administered was test A which took respondents one week to complete. Test B was administered one week after the first was collected. It also took one week to complete. Table 3.5 below gives a summary of the means and standard deviations of the two sets of responses to the two tests.

TABLE 3.5: Summary of means and standard deviations of the two tests for pilot study.

RESPONDENTS	IINSTRUMENT A		IINSTRUMENT B	
	Mean	SD	Mean	SD
Mathematics Lecturers	18.07	4.80	18.27	4.26
Engineering Courses Lecturers	19.4	3.33	19.33	2.86

N = 30

From the above table, it can be seen that the two tests tend to have almost equal means and standard deviations. This is an indication that respondents generally had similar scores on both tests. This fact is further buttressed by the relatively high estimates of parallel form reliability coefficient as shown in table 3.3 above.

3.8 Summary

So far, an outline of the operational blue print used to conduct the research has been presented. Out of the 125 mathematics lecturers and 355 engineering courses lecturers that made up the population, the respective number used as samples were fifty-six and 158. The instrument used was the polytechnic mathematics curriculum evaluation instrument. The first and second section was completed by the lecturers used as samples while the third and fourth was completed by the researcher because they are checklists. The questionnaire for mathematics lecturers has a reliability coefficient of 0.73 while that for the engineering courses lecturers has 0.76. The researcher administered the instrument personally.

Finally, the chi-square statistic was used to test the first and fourth null hypothesis while the second and third were tested using the t-test statistic.

Chapter 4

PRESENTATION AND ANALYSIS OF DATA

4.0 Introduction

1. In this chapter, the data collected is presented and analysed. As already stated in the preceding chapter, both descriptive and statistical analysis of the data collected will be presented. In the course of the presentation and analysis of the data collected, answers to the research questions and the results of the research hypotheses tested will be sought and presented respectively. The data presentation and analysis will be followed by hypotheses testing and discussion of the results obtained.

4.1 Data Presentation and Analysis

4.1.1 Demographic Data

The data presented in this section was derived from the responses of the subjects to section 1 of the PMCEI (Appendix B). This data makes it possible to answer the first research question, which states that "what are the characteristics, in the terms of highest educational qualification and length of service of the mathematics lecturers and their non-mathematics counterparts teaching engineering courses/subjects in the polytechnics studied?"

The subjects utilized in the study were made up of 56 mathematics lecturers and 158 engineering courses/subjects lecturers randomly selected from Yaba College of Technology, Lagos; Kaduna Polytechnic,

Kaduna; Institute of Management and Technology, Enugu and Auchi Polytechnic, Auchi. Table 4.1 below gives a summary of the characteristics of the subjects in terms of their highest educational qualification and length of service.

Table 4.1 Distribution of subjects by highest educational qualification and length of service.

CHARACTERISTICS		SUBJECTS			
		ML		ECL	
		F	%	F	%
HIGHEST EDUCATIONAL QUALIFICATION	HND	0	0	13	8.2
	PGD	0	0	40	25.3
	FIRST DEGREE	42	75.0	89	56.3
	SECOND DEGREE	12	21.4	16	10.2
	THIRD DEGREE	2	3.6	0	0
	TOTAL	**56**	**100**	**158**	**100**
LENGTH OF SERVICE	2 YEARS AND BELOW	8	14.3	12	7.6
	3 TO 5 YEARS	14	25.0	33	20.9
	6 TO 10 YEARS	26	46.4	95	60.1
	11 TO 15 YEARS	5	8.9	16	10.1
	ABOVE 15 YEARS	3	5.4	2	1.3
	TOTAL	**56**	**100**	**158**	**100**

NOTE: In the table, ML, = Mathematics Lecturers, ECL = Engineering Courses/subjects Lecturers, F = Frequency and % = Percentage

It can be seen from the table that most of the lecturers have first degree and most have spent between six and ten years in teaching. Contrasting the distribution of the two sets of lecturers, it can be seen that

while first degree is the lowest educational qualification of the mathematics lecturers, that of the engineering courses/subjects lecturers is HND. Furthermore, non of the engineering courses/subjects lecturers have a third degree while about 3.6% of the mathematics lecturers have third degree.

Finally, contrasting the two groups in terms of their length of services, it can be seen that the proportion of lecturers who have spent between six and ten years in service is more with the engineering courses/subjects lecturers. However, the proportion that has spent above fifteen years in service is more with mathematics lecturer.

4.1.2 Questionnaire Data

The data used in this section was derived from the respondents mean opinion score per item for all the 110 items scored in section II (i.e the questionnaire part) of the PMCEI (Appendix G). Each mean opinion score per curriculum item was obtained by summing all the scores for that item and then dividing it by the number of respondents in the group.

Research Question 2

To what extent are the general objectives of the current N.B.T.E polytechnic mathematics curriculum attainable?

The data used to answer the above question was derived from the respondents mean opinion score per curriculum item (Appendix G) for the first seven items (items 1 – 7) of Section II of the PMCEI. These items assess the subjects' opinions regarding the attainability of the curriculum's general objectives. The mean of the scores of both groups of respondents combined was obtained. Table 4.2 below summarises the results.

Table 4.2 Mean score for curriculum items assessing attainability of general objectives.

Number of Responses	14
Sum of scores	31.14
Mean	2.22

From the above table, it can be deduced that a mean of 2.22, which is approximately 2.0, indicates (Section 3.4) that the lecturers are of the opinion that the curriculum's general objectives are fairly attainable.

Research Question 3

> How relevant are the instructional objectives of the current N.B.T.E polytechnic mathematics curriculum to the general objectives?

The data used to answer the above question was derived from the respondents mean opinion score per curriculum item (Appendix G) of 41 items (i.e items 29 – 69) of section II of the PMCEI. These items assess the relevance of the curriculum's instructional objectives to the general objectives. The mean of the scores for both groups of respondents combined was obtained. Table 4.3 below summarises the result.

Table 4.3 Mean score for curriculum items assessing relevance of instructional objectives to general objectives

Number of Responses	82
Sum of scores	210.82
Mean	2.57

From the above table, it can be seen that the mean of 2.57 obtained, which is approximately 3.0, indicates (Section 3.4) that in the opinion of the respondents, the instructional objectives are relevant to the general objectives.

Research Question 4

> To what extent are the contents of the current N.B.T.E polytechnic mathematics curriculum relevant to their objectives?

The data used to answer the above question was derived from the respondents mean opinion score per curriculum item (Appendix G) of fourty-one items (i.e item 70 – 110) of section II of the PMCEI. These items assess the relevance of the curriculum's contents to their objectives. Table 4.4 summarises the result.

Table 4.4 Mean score for curriculum items assessing relevance of contents to objectives.

Number of Responses	82
Sum of scores	237.45
Mean	2.90

From the above it can be seen that the mean of 2.90 obtained, which is approximately 3.0, indicates(Section 3.4) that the respondents are of the view that the curriculum's contents are relevant.

Research Question 5

> How balanced is the scope/area of coverage of contents of the current N.B.TE. Polytechnic mathematics curriculum in relation to its general objectives?

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The data used to answer the above question was derived from the respondents mean opinion score per curriculum item (Appendix G) of seven items (i.e item 8 – 14) of section II of the PMCEI. These items assess the balance in scope/area of coverage of contents of the curriculum in relation to the general objectives. Table 4.5 summarises the result.

Table 4.5 Mean score for curriculum items assessing balance of the scope/area of coverage of contents.

Number of Responses	14
Sum of scores	39.72
Mean	2.84

From the above table it can be deduced that a mean of 2.84 which is approximately 3.0, is an indication (Section 3.4) that the respondents are of the view that the balance of scope/area of coverage of the curriculum's contents is adequate.

4.1.3 Checklist Data

Research Question 6

> To what extent are the resources (human and material) needed for the successful implementation of the current N.B.T.E polytechnic mathematics curriculum adequate in the institutions covered during research?

The data used to answer the above question was derived from the researcher's investigation in the mathematics/statistics departments of the institutions visited. This investigation form the basis for the completion of sections III and IV of PMCEI (Appendix B) Table 4.6 below gives a summary of the distribution of adequacy of mathematics lecturers by ranks in the institutions visited.

Table 4.6 Distribution of required and available mathematics lecturers by ranks in institutions visited.

RANKS	Number Required	Number Available
Chief Lecturer	4	2
Principal Lecturer	7	5
Senior Lecturer	22	15
Lecturer I	38	23
Lecturer II	43	34
Lecturer III	50	31
Assistant Lecturer	25	14
TOTAL	**189**	**124**

From the data in the above table, it can be seen that the percentage of mathematics lecturers available for the implementation of the provisions of the curriculum is about 66. Therefore, these institutions can be regarded as being fairly adequately staffed to implement the curriculum's contents.

As regards the facilities needed, it was discovered that apart from the basic infrastructures necessary for formal education such as classrooms, with chalkboards and seats, no specific provisions were made either in the curriculum or by these institutions to address this dimension of curriculum implementation.

4.2 Hypotheses Testing

The data used in this section was derived from the responses of the subjects to section II (i.e the questionnaire part) of the PMCEI. The responses to the 110 items by the fifty six mathematics and 158 engineering courses/subjects lecturers are respectively displayed in appendices C and E while their corresponding scores are displayed in appendices D and E.

4.2.1 Hypothesis 1

Ho_1: There is no significant difference among the opinion of the mathematics lecturers regarding the attainability of the general objectives of the current N.B.T.E polytechnic mathematics curriculum?

The above null hypothesis was tested using the chi-square statistic. The data used was derived from the mathematics lecturers' responses to the first seven items (i.e items 1 – 7) of section II of the PMCEI. These items assess the respondents' opinion on the attainability of the curriculum's general objectives. Table 4.7 below gives a summary of the frequency of responses per curriculum item and option.

Table 4.7 Mathematics lecturers frequency of responses for curriculum items assessing attainability of general objectives.

Option	Curriculum Items							TOTAL
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	
Fully Attainable	4	2	6	4	2	0	3	21
Attainable	11	8	14	6	10	10	9	68
Fairly Attainable	39	42	34	40	35	45	34	269
Not Attainable	2	4	2	6	9	1	10	34
TOTAL	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**392**

NOTE: In the table, C_1 = Curriculum item one, C_2 = Curriculum item two, and so on.

lecturers on curriculum items assessing relevance of instructional objectives to the curriculum's general objectives.

Table 4.8: t-test between mathematics and engineering courses/subjects lecturers mean opinion score on relevance of *instructional objectives to general objectives.*

Variable	N	Mean	Variance	t-value(cal)	df	P
ML mean opinion score	41	2.8988	0.0075	39.00	40	0.05
ECL mean opinion score	41	2.2537	0.0041			

NOTE: In the table, ML = mathematics lecturers, ECL = engineering *courses/subjects lecturers.*

At the 0.05 level of significance for 40df, the critical value of t (i.e t_{tab}) = 2.02. As can be seen from the table above, $t_{cal} = 39.00 > t_{tab} = 0.20$ at the 0.05 level of significance for the same 40df. Therefore, the above null hypothesis is rejected.

4.2.3 Hypothesis 3

Ho_3: There is no significant difference between the mean opinions of the mathematics lecturers and those of the engineering courses/subjects concerning the relevance of the contents of the current N.B.T.E polytechnic mathematics curriculum to its objectives.

The t-test statistic was employed to test the above null hypothesis. The data used was derived from the respondents' mean opinion scores per curriculum item (Appendix G) for 41 items (i.e items 70 – 110) of

From the above contingency table, a chi-square value of 0.04 was obtained (i.e $X^2 = 0.04$). The appropriate degrees of freedom for the above table is (4-1) (7 – 1) = 18. For this degree of freedom, the tabulated or critical value of chi-square at the 0.05 level of significance is 28.869. Since the calculated chi-square value for the above contingency table is far less than the critical chi-square value (i.e $X^2_{cal} = 0.04 < X^2_{tab} = 28.869$)

for 18df at the 0.05 level of significance, this null hypothesis is retained.

4.2.2 Hypothesis 2

> Ho_2: There is no significant difference between the mean opinions of the mathematics lecturers and those of the engineering courses/subjects lecturers regarding the relevance of instructional objectives to the general objectives of the current N.B.T.E polytechnic mathematics curriculum.

The above null hypothesis was tested by means of the t-test statistic. The data used was derived from the respondents' mean opinion scores per curriculum item (Appendix G) for 41 items (i.e items 29 – 69) of section II of the PMCEI. These items assess the subjects' opinions regarding the relevance of instructional objectives to general objectives of the curriculum (Appendix B). The mean opinion score per item was obtained by dividing the sum of scores for that item by the number of respondents in that group. Table 4.8 below gives a summary of the t-test between the mean opinions of mathematics and engineering courses/subjects

section II of the PMCEI. These items assess the subjects' opinions regarding the relevance of the curriculum's contents to its objectives (Appendix B). Table 4.9 below gives a summary of the t-test between the mean opinions of the mathematics and engineering courses/subjects lecturers on the curriculum items assessing relevance of contents to objectives.

Table 4.9 t-test between mathematics and engineering courses/subjects lecturers mean opinion score on relevance of curriculum contents to objectives.

Variable	N	Mean	Variance	t-value(cal)	df	P
ML mean opinion score	41	2.8932	0.0248	1.20	40	0.05
ECL mean opinion score	41	2.8632	0.0013			

At the 0.05 level of significance, for 40df, the critical value of t (i.e t_{tab}) = 2.02. As can be seen from the above table, $t_{cal} = 1.20 < t_{tab} = 2.02$ at the 0.05 level of significance for the same 40df. Therefore the above null hypothesis is retained.

4.2.4 Hypothesis 4

Ho_4: There is no significant difference among the opinions of the engineering courses/subjects lecturers regarding the applicability of contents to student areas of specialization in the current N.B.T.E polytechnic mathematics curriculum.

The chi-square statistic was employed to test the above null hypothesis. The data used was derived from the engineering courses/subjects lecturers responses to seven items (i.e items 22 – 28) of section II of the PMCEI. Table 4.10 below gives the frequency of

responses per item for these seven items assessing applicability of curriculum contents to areas of specialization.

Table 4.10 Engineering courses/subjects lecturers frequency of response for curriculum items assessing applicability of contents to areas of specialization.

Option	Curriculum Items							TOTAL
	C_{22}	C_{23}	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	
Highly Applicable	8	5	7	17	12	19	10	78
Applicable	121	130	125	129	140	126	103	874
Fairly Applicable	27	22	22	10	6	10	40	137
Not Applicable	2	1	4	2	0	3	5	17
TOTAL	**158**	**158**	**158**	**158**	**158**	**158**	**158**	**1106**

From the above contingency table, a chi-square value of 0.00 was obtained (i.e $X^2 = 0.00$) Like in section 4.2.1, the appropriate degrees of freedom for the above table is 18. And for this degrees of freedom, the critical chi-square value (i.e X^2_{tab}) is 28.87 at the 0.05 level of significance. Since the calculated chi-square value is far less than the tabulated value (i.e $X^2_{cal} = 0.00 < X^2_{tab} = 28.87$) for 18df at 0.05 level of significance, the above null hypothesis is retained.

4.3 Discussions

In the preceding sections, data bordering on the demographic characteristics of the subjects used was presented. Also, the four research hypotheses stated in the null forms, were tested and answers to the six research questions provided. A major observation arising from the demographic data is that both groups of subjects possess at least the minimum educational qualification necessary for their job as lecturers in

the institutions covered. This therefore implies that the demographic data helps to clearly establish the suitability of both groups of subjects for the evaluation of the curriculum in context. For, the suitability of using teachers teaching a course to evaluate same have deep rooted support in the works of Dressel (1985), Worthen and Sanders (1973), Fitzgerald (1976), Drenth et al (1989), Afe (1991) and Gulma (1999) among others. Consequently, the data used for hypotheses testing and analysis for answering of research questions are quite suitable for the purposes to which they were utilized.

The hypotheses testing carried out led to the non-rejection of the first, third and fourth hypotheses while the second was rejected. The retention of the first null hypothesis is an indication that the subjects used are of homogeneous opinion regarding the attainability of the curriculum's general objectives. This is important in that it lend credence to the answer found for the first research question. In this regard, it is not surprising that the respondents are of the view that the curriculum's general objectives are fairly attainable. For, it was observed in statement of the problem that the general objectives were not stated in behavioural terms. A fact which contradicts established mode of stating educational objectives.

That differences were found to exist between the two groups opinions regarding the relevance of the curriculum's instructional objectives to the general objectives might be attributed to the already existing difference in the field of study of the two groups. This might have impacted on their view about the utility of the curriculum's contents. It is interesting to note that this difference in opinion between the two groups does not necessary imply that the instructional objectives are not relevant to the general objectives. In fact, they have been found to be relevant.

This line of reasoning can be said to have been supported by respondents' consideration of the curriculum's contents as being relevant

to their objectives. Further confirmation of this can be located in the retention of the third null hypothesis i.e that no significant difference exist between the opinions of the two groups regarding the relevance of the curriculum's contents to its objectives. The retention of the fourth null hypothesis and the answer to the fifth research question on the adequacy of balance in scope/area of coverage of the curriculum's contents goes along way to establish that the current N.B.T.E polytechnic mathematics curriculum is still adequate for the needs of the students and the nation.

It is interesting to note that even though the staff available for the implementation of the curriculum was found to be fairly adequate, this did not make respondents consider the six dimensions of a curricular entity being evaluated from a negative perspective. For, it would have been expected that the workload of these lecturers, being in excess, on the account of their inadequate availability, would have made them view the contents in a negative light. Conclusively therefore, a considerable measure of objectivity can be said to have been expressed in the subjects responses to the PMCEI.

4.4 Summary

So far, a detailed presentation of the data collected has been done along with analysis that helped in the research hypotheses testing and answering of the research questions. In this regard, the first, third and fourth research hypotheses were retained while the second was rejected. All the four null hypotheses were tested at the 0.05 level of significance. Analysis of the data collected showed that the general objectives of the curriculum are fairly attainable, the contents of the curriculum are relevant to their objectives and that the balance of scope of the contents of the curriculum is adequate. Finally, data from the checklist showed that institutions covered are fairly adequately staffed to implement the contents of the curriculum and that no special material provisions are

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made or recommended in the curriculum or by the authorities of the institutions covered in order to successfully implement the provisions of the curriculum.

Chapter 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

The background information to the subject matter of this research was presented in chapter one. A statement of the problem and the purpose of the study followed it. Six research questions and four research hypotheses stated in the null from were raised. The scope and delimitation of the study was discussed. In chapter two, extensive review of literature related to the research topic was presented and in chapter three, the operational blue print employed to conduct the research was outlined in detail. In the preceding chapter the data collected was presented and analysed in which process the answers to the research questions were found and the hypotheses tested. In this final chapter, the following are presented

1. Summary
2. Conclusion
3. Recommendations
4. Recommendations for further studies

5.1 Summary

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

The problem of the study emanated from the absence of post–implementation evaluation information on the attainability of both the general and instructional objectives of the curriculum, the relevance of the curriculum contents to their objectives, the balance and scope of the curriculum contents and the applicability of the curriculum contents to students' areas of specialization.

Had such information been available, it might have the potential of assisting decision makers to make meaningful improvements in the curriculum. This short coming has led to an inadequate method of addressing students persistent complains, as experienced by the researcher, that the curriculum contents have no direct bearings on their areas of specialization. Another problem area observed is the inappropriate manner in which the curriculum objectives were framed. These objective were not behaviourally stated which contradicts established mode of starting educational objectives.

Based on the above problem statement, the major purpose of the study was to evaluate the curriculum in order to determine the extent to which its general objective are attainable and to also find out how relevant these objectives are to both the students and the nation's current and future technological needs.

Six research questions and four research hypotheses stated in the null form were raised and tested respectively in order to meet the purpose of the study. While the first research question focused on the demographic characteristic of respondents, the second and third focused on the attainability of the curriculum's generals objectives and their relevance to the instructional objectives respectively. The fourth and fifth research questions were focused respectively on the relevance of the curriculum contents and the curriculum's contents balance and scope of coverage. The sixth focused on the resources needed for successful implementation of the provisions of the curriculum.

The first and fourth hypotheses focused on the differences of opinion among each of the two groups of subjects used regarding the attainability of the curriculum objectives and applicability of content to areas of specialization. The second and third focused on the differences in opinions between the two groups as it relates to the relevance of the curriculum contents to its objective and the relevance of instructional objectives to the general objectives of the curriculum. This study was based on the assumption that personnel saddled with the responsibility of implementing curricular provisions are very relevant sources of information with respect to the adequacy of such provisions for current and future needs of both students and the nation. It was also assumed that the instruments used to collect data are appropriate to obtain the desired information.

The study was meant to cover all polytechnics in Nigeria but for practical administrative seasons, four were selected and used as sample. These four polytechnic are the first set in the history of polytechnic education in Nigeria and are located in four different geo-political zones of the country. The study was delimited to the two year ND and two year HND mathematics curriculum programmes for engineering students. Other N.B.T.E mathematics curriculum programmes such as those for the pre –ND and post HND were not examined in this study.

Literature encountered by the researcher revealed that there is virtually no published research work bordering on mathematics curriculum evaluation studies for Nigerian polytechnics in general and the current N.B.T.E mathematics curriculum for Nigerian polytechnics in particular. Consequently, most curriculum evaluation studies reviewed were those conducted for other levels of our education system and other subject areas both in Nigeria and abroad. However, these studies have a lot of implications for this study.

The review of literature was approached from two main perspectives: the theoretical frame work and the related literature. Both perspectives were intertwinely presented. Literature reviewed confirmed the importance of this type of curriculum evaluation study and the dimensions of curricula entity addressed in the PMCEI. These dimensions led to the identification of teachers, contents and objectives as the most important of the crucial factors in curriculum implementation process. Several investigations considered the teacher as the key factor in the operation and for the success of any curriculum implementation. Therefore, the choice of teachers as the central point of focus in the study had the backings of a significant majority of the works reviewed. The reports and studies in technology education had all showed that not much attention and priority had been accorded this type of study in comparison to other types in the field of education. Thus, this study could be viewed as an attempt to project into focus this type of educational research work.

The data for this study was collected between 17 July and 23 August, 2000. The researcher personally administered the research instrument in all the four institutions used, and collected them with the help of one research assistant in each of the institutions. The subjects used for the study were the mathematics lecturers and their counterpart teaching engineering courses/subjects. The instrument for the study was the PMCEI. The researcher in line with existing instruments developed it. It is made up of four sectors. Section I seeks information on demographic characteristics of respondents.

Section II is a 110 item-four point Likert type of instrument. Each statement of every item ends with four options that make the statement either completely favourable, favourable, fairly favourable or not favourable to the curriculum aspect being evaluated. Respondents were required to choose one of these options in each item. This section of the PMCEI was designed to seek information bordering on respondents

perceptions and views on six dimensions of a curricula entity. This section of the PMCEI and the previous one was administered on a sample of fifty-six mathematics and 158 engineering courses/subjects lecturers from the institutions used. Pilot testing of this section of the instrument on a sample of thirty mathematics and thirty engineering courses/ subjects lecturers made it possible of establish a reliability coefficient of 0.733 and 0.757 respectively for mathematics lecturers and engineering courses/subjects lecturers instrument.

Both descriptive and statistical procedures were used to analyze the date collected. The null hypotheses were tested with appropriate statistics. The data analysis technique included the following:- frequencies, means, chi-square and t-test. Frequencies were used to display the number of responses to each option of each item. The means of these responses per item were calculated and used in the calculation of the t-value for the t-test statistic which was employed to test the second and third null hypotheses of no difference between the two groups of the samples used. The chi-square statistic was used to test the first and fourth null hypotheses of no difference in opinions among each of the two groups of the samples used. The 0.05 level of significance was used in testing all the hypotheses.

5.2 Conclusion

Based on the descriptive and statistical analyses of the data collected in this study, which have been presented in chapter four, the following conclusions were arrived at from the major findings.

1. Majority of lecturers currently teaching either mathematics or engineering courses/subjects in Nigerian polytechnics have first degrees. Therefore, most personnel implementing the provisions of the current N.B.T.E polytechnic mathematics curriculum posses the

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minimum basic qualification necessary for successful implementation.

2. Majority of the lecturers currently teaching either mathematics or engineering courses/subjects in Nigerian polytechnics has spent between six and ten years teaching. Therefore most personnel implementing the current N.B.T.E polytechnic mathematics curriculum have the working experiences necessary for proper implementation of the provisions of the curriculum.
3. No significant differences in opinions exist among mathematics lecturers regarding the attainability of the general objectives of the current N.B.T.E polytechnic mathematics curriculum.
2. The general objectives of the current N.B.T.E polytechnic mathematics curriculum are fairly attainable.
5. Significant difference was found between the opinions of mathematics lecturers and those of engineering courses/subjects lecturers regarding the relevance of instructional objectives to general objectives in the current N.B.T.E polytechnic mathematics curriculum.
6. The instructional objectives of the current N.B.T.E polytechnic mathematics curriculum are relevant to their general objectives.
7. There exist no significant difference between the opinions of mathematics lecturers and those of engineering courses/subjects lecturers concerning the relevance of the contents to their objectives in the current N.B.T.E mathematics curriculum.
8. The contents of the current N.B.T.E polytechnic mathematics curriculum are relevant to their objectives.
9. No significant differences in opinions was found among engineering courses/subjects lecturers concerning the applicability

of contents to students areas of specializations in the current N.B.T.E polytechnic mathematics curriculum.

10. The balance in scope of the contents of the current N.B.T.E polytechnic mathematics curriculum is adequate.
11. The number of mathematics lecturers available for the implementation of the provisions of the current N.B.T.E polytechnic mathematics curriculum is barely adequate.
12. No specific material provisions were recommended for usage in teaching of the contents of the current N.B.T.E polytechnic mathematics curriculum.
13. Statement of the general objectives of the current N.B.T.E polytechnic mathematics curriculum is not in conformity with established standard for stating educational objective.

5.3 Recommendations

Consequent upon the conclusions arrived at in the preceding section, the following recommendations are made in these section.

a. There is a need for a method to be devised which will encourage and at the same time compel mathematics lecturers in Nigerian polytechnics to go for further studies so that majority of the personnel saddled with the implementation of the provisions of the curriculum will have a minimum qualification of second degree.
b. The general objectives of the current N.B.T.E polytechnic mathematics curriculum needs to be reframed so that it conforms with established standard of stating educational objectives. In other words, the general objectives need to be behaviourally stated. To this extent a proposal of the reframed objectives is as follows:

A. **COURSE TITLE:** MTH III - Logic and Linear Algebra

GENERAL OBJECTIVES: On completion of this course, the student should be able to.

1.0 State the basic rules of mathematical logic and apply them to mathematical proofs.

2.0 Make use of permutations and combinations in his/her area of specialization.

3.0 Make use of the binomial theorem to expand algebraic expressions and compute approximate values of related decimal numbers.

4.0 Perform algebraic operations of matrix addition, subtraction, multiplications etc and the evaluation of determinants as well as solving of simultaneous linear equations by the method of matrices.

B. **COURSE TITLE:** MTH 112 - Algebra and elementary trigonometry.

GENERAL OBJECTIVES: On completion of this course, the student should be able to.

1. State the laws of indices and apply them in simplifying algebraic expressions
2. Explain the theory of logarithms and surds and apply them in manipulating expressions.
3. Explain the principles underlying the construction of charts and graphs.
4. Solve quadratic equations using all the different methods.
5. Make use of permutations and combinations to solve problems in his/her area of specialization.

6. Apply the concept of set theory to solution of problems in his/her area of specialization.
7. Explain the properties of Arithmetic progression and Geometric progression and apply them to solving problems in his/her area of specialization.
8. State the binomial theorem and apply it in the expansion of algebraic expression and in approximations.
9. Explain the basic concepts of vectors, manipulate them algebraically and apply them to solve engineering problems.
10. Explain the concept of equations, state methods of solving different types of equations and apply them to solve engineering problems.
11. Define trigonometric functions, manipulate them and apply them to solve engineering problems.

C. **COURSE TITLE:** MTH 122 - Trigonometry and Analytical Geometry

GENERAL OBJECTIVES: On completion of this course, the student will be able to.

1. Manipulate Trigonometric formulae and apply the formulae to solve trigonometric equations.
2. Explain the concepts in menstruation and apply them to solve engineering problems
3. Explain the concepts in analytical geometry and apply them to solve engineering problems.
4. State different forms of conics and solve problems on conic section.

D. **COURSE TITLE:** MTH 211 - Calculus

GENERAL OBJECTIVES: On completion of this course, the student should be able to.

1. Explain the basic concepts of differential calculus, solve problems in differential calculus and solve engineering problems using methods of differential calculus.
2. Explain the concept of integration as the reverse of differentiation, solve problems in integral calculus and solve engineering problems using methods of integral calculus.
3. Make use of first order homogeneous linear ordinary differential equations with constant coefficients to solve engineering of problem.
4. Explain the basic concepts of partial differentiation and apply same to solve engineering problems.

E. **COURSE TITLE**: MTH 311 - Advanced Algebra

GENERAL OBJECTIVES: On completion of this course, the student should be able to.

1. Define exponential, logarithmic and hyperbolic functions and state the relationships between them, as well as perform various manipulations involving them.
2. State power, Maclaurin's and Taylor's series and apply them to solve logarithmic, trigonometric and hyperbolic functions based problems.
3. Solve second order differential equations
4. Solve simultaneous differential equations of order two.
5. Explain the process of solving partial differential equations and apply them to solve engineering problems.
6. Explain the concepts of functions of several variables and their uses.

G. **COURSE TITLE:** MTH 321 - Numerical Methods

GENERAL OBJECTIVES: On completion of this course, the student should be able to.

1. Use numerical methods to solve linear and non-linear equations.
2. Explain the concept of finite differences and form finite difference tables.
3. Use finite difference tables to interpolate and extrapolate
4. Perform numerical differentiation
5. Perform numerical integration
1. Solve first and second order ordinary differential equations by numerical method.

c. Specific materials needed for successful implementation of the provisions of the current N.B.T.E mathematics curriculum for Nigerian polytechnics be recommendation in the curriculum.

d. The current N.B.T.E polytechnic mathematics curriculum should be retained.

5.4 Recommendation for further research

The following recommendations are based on the researchers findings and conclusion arrived at in this study.

a. The N.B.T.E should endeavour to replicate this study periodically in order to be well informed about the state of functionality of the curriculum.

b. Similar studies should be conducted by the N.B.T.E or researchers in other fields for all polytechnics in Nigeria.

c. A survey of polytechnic graduates in industries should be carried out with the objective of finding out the utility of mathematics taught them in their job.

d. A detailed comparative study bordering on the content difficulty versus level at which content is recommended to be taught should be carried out to ascertain whether students complains are baseless or not.

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APPENDIX A

THE N.B.T.E. MATHEMATICS CURRICULUM FOR NATIONAL DIPLOMA AND HIGHER NATIONAL DIPLOMA PROGRAMMES

COURSE TITLE: MTH III - Logic and Linear Algebra

DURATION: 30 Hours

LEVEL: National Diploma: All programmes

COURSE UNIT: 2.0

GOAL: This course is intended to enable students develop precise logical and abstract thinking and the ability to recognize, formulate and evaluate problems in their areas of specialization in areas such as logic and solution of linear and simple non –linear equations.

GENERAL OBJECTIVES: On completion of this course the student will be able to:

1.0 Understand the basic rules of mathematical logic and their application to mathematical proofs.
2.0 Know permutations and combinations.
3.0 Compute the binomial expansion of algebraic expansions.
4.0 Understand the algebraic operations of matrices and determinants as well as solve simultaneous linear equations by the methods of matrices.

GENER AL OBJECTIVES	PERFORMANCE OBJECTIVES
1.0 Understand the basic rules of mathematical logic and their application to mathematical proofs.	On completion of this course, the student should be able to: **LOGIC** 1.1 Define the essential connectives, negation, conjunction, disjunction, implication and bi-implication.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	1.2 Illustrate the essential connective in 1.1 above 1.3 Describe grouping and parenthesis in 1.4 Explain Truth Tables. 1.5 Define tautology. 1.6 Give examples of types of tautology e.g (i) If P and Q are distinct atomic sentences, which of the following are tautologies? (a) P – Q (b) PUQ – QUP (c) PV (b) (P&Q) (ii) Let P = Jane Austin was a contemporary of Beethoven Q = Beethoven was a contemporary of Gauss. R = Gauss was a contemporary of Napoleon. S = Napoleon was a contemporary of Julius Caesar. (Thus P, Q and R are true, and S is false). Then find the truth values of sentences:- (a) (P & Q) = R (b) (P – Q) (c) P & Q – R – S 1.7 Define universal quantifier and existential quantifier. 1.8 Translate sentences into symbolic form using quantifier e.g. 'some freshmen are intelligent" can be stated as for some x, x, is a freshman and x is intelligent' can translate in symbols as (/x) (F x & x).

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GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	1.9 Define the scope of a quantifier 1.10 Define 'bound and 'free' variables 1.11 Define 'term' and 'formula' 1.12 Give simple examples of each 1.9 to 1.11 above. 1.13 Explain the validity of formulae. **PERMUTATIONS AND COMBINATIONS** 2.1 Define permutations and combinations. 2.2 Give illustrative examples of ach of 2.1 above 2.3 State and prove fundamental principle of permutation. 2.4 Give illustrative examples of the fundamental principles of permutation. 2.5 Establish the formula ${}^{n}P_{r} = \frac{n!}{(n-r)!}$ 2.6 Prove that ${}^{c}P_{r} = {}^{(n-r+1)\times n}P_{(r-1)}$ 2.7 Solve problems of permutations with restrictions on some of the objectives. 2.8 Solve problems permutations in which the objects may be repeated. 2.9 Describe circular permutations. 2.10 Solve problems of permutations of N things not all different.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	2.11 Establish the formula $^nC_r = \frac{n!}{r!\,(n-r)!}$ 2.12 Illustrate 2.11 above 2.13 State and prove the theorem $^nC_{(r-1)} + {}^nC_r = {}^{(n+1)}C_r$ 2.14 Solve problems of combinations with restrictions on some of the objects. 2.15 Solve problems of combination of n different things taken any number at a time.
3.0 Complete the binomial expansion of algebraic expressions	**BINOMIAL THEOREM** 3.1 Explain with illustrative examples – the method of mathematical induction. 3.2 State and prove binomial theorem for positive integral index. 3.3 Describe the properties of binomial expansion. 3.4 State at least seven (7) examples of 3.3 above e.g. (i) $A\,(x^2 - 1/x)$ (ii) Find the constant term in the expansion of $(x + 1/x)^A$ (iii) Find the efficient of x^v in the expansion of $(x \pm K)^A$ where v is a number lying between –n and n.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	3.5 State the binomial theorem for a rational number. 3.6 State the properties of binomial coefficients. 3.7 Apply binomial expansion in approximations (simple examples only) **MATRICES AND DETERMINANTS** 4.1 Define Matrix 4.2 Define the special matrices – zero matrix,identity matrix, square matrix, triangular matrix symmetric matrix, skew symmetric matrix. 4.3 State examples for each of the matrices in 4.2 above. 4.4 State the laws of addition and Multiplication of matrices. 4.5 Illustrate the commutative, associative and distributive nature of the laws stated in 4.4 above. 4.6 Define the transpose of a matrix. 4.7 Determine a determinant for 2 by 2 and 3 by 3 matrices. 4.8 Define the minors and cofactors of a determinant. 4.9 Explain the method of evaluating determinants. 4.10 State and prove the theorem "two rows or two columns of a matrix are identical, then the value of it's determinant is zero".

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	4.11 State and prove the theorem "if two row or two columns of a matrix are interchanged, the sign of the value of its determinant is changed". 4.12 State and prove the theorem if any one row or one of a matrix s multiplied by a constant, the determinant itself is multiplied by the constant. 4.13 and prove the theorem "if a constant times the elements of a row or a column are added to the corresponding elements of any other row or column, the value of the determinant itself is multiplied by the constant". 4.14 State five examples of each of the theorems in 4.10 – 4,13 above. 4.15 Define the adjoint of a matrix. 4.16 Define the inverse of matrix. 4.17 State the linear transformations on the rows and column of a matrix. 4.18 Apply Crammer's rule in solving simultaneous linear equations. 4.19 Apply linear transformation in solving simultaneous linear equation.

COURSE TITLE: MTH 112 Algebra and Elementary Trigonometry

DURATION: 30 Hours

COURSE UNIT: 2.0

GOAL: This course is intended to enable the students acquire basic knowledge of Algebra and Trigonometry and apply same in solving problems in their areas of specialization

1.0 Understand the laws of indices and their applications in simplifying algebraic expressions.

2.0 Understand the theory of logarithms and surds and their applications in manipulating expressions.

3.0 Understand principles underlying the construction of charts and graphs.

4.0 Know the different methods of solving quadratic equations.

5.0 Understand permutation and combination.

6.0 Understand the concept of set theory.

7.0 Understand the properties of arithmetic and geometric progressions.

8.0 Understand the binomial theorem and it's application in the expansion of expressions and in approximations.

9.0 Understand the basic concepts and manipulation of vectors and their applications to the solution of engineering problems.

10.0 Understand the concept of equations and methods of solving different type of equations and apply same to engineering problems.

11.0 Understand the definition, manipulation and application of trigonometric functions.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	On completion of this course, the student should be able to:-
1.0 of indices and their application in simplifying algebraic expressions.	**INDICES** 1.1 Define index 1.2 Establish the laws of indices 1.3 Solve simple problems using the laws of indices.
2.0 Understand the theory of logarithm and surds and their applications in manipulation expressions.	**LOGARITHMS AND SURDS** 2.1 Define logarithm 2.2 Establish the four basic laws of logarithms. 2.3 Exemplify logarithm. 2.4 Define natural logarithm and common logarithm. 2.5 Define characteristic and mantissa. 2.6 Read the logarithm table for given numbers. 2.7 Simplify numerical expressions using log tables e.g. 18D $= ^{3}$ 4jpc2Λm^{8} find D when J = 0935, e.g. Ø $\sqrt[3]{35}$, P = 1.6 X 10^{6}, C = 55, M = 00025, Λ = 3142. 2.8 Apply logarithm in solving non – linear equations e.g. dx^{n}logy–loga + nlogx, y=bc^{x} – logy – logb + xlogc Y = a + bx^{n} – log (Y – D) = log b) + ngx 2.9 Define surds.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	2.10 Reduce a surd into its simplest form. 2.11 Carry out the Algebra of surds. **GRAPHS** 3.1 Construct graphs of functions Such as Y = ax + b, x = 1, 2. Y = CST (a + x), Y = ax^k, including cases of asymbles. 3.2 Apply knowledge from 3.1 in determination of laws from experimental data. **THEORY OF QUADRATIC EQUATION** 4.1 Solving quadratic equations by factorization. 4.2 Solving quadratic equations by method of completing squares. 4.3 Solving quadratic equations by formula. 4.4 Discriminate the roots. 4.5 Form equations whose roots are given in different methods. **PERMUTATIONS AND COMBINATIONS** 5.1 Define permutation. 5.2 State examples of permutations. 5.3 Define combination. 5.4 State eamples of combinations. 5.5 Establish the theorem $^nP_r = \frac{n!}{(n-r)!}$ giving examples e.g the number of ways of collecting two our of 8 balls is $^8C_2 = 8!/2!(8-2)!$, n!/r (n – r)! giving examples

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GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
6.0 Understand the concept of set theory.	**SET THEORY** 6.1 Establish ${}^{n}C_{r} = {}^{n}C_{n-r}$ 6.2 Define sets, subsets and null sets. 6.3 Define union, inter-section and complement of sets. 6.4 Draw Venn diagrams to demonstrate the concept in 6.1 – 6.3 above. 6.5 Calculate the size or number of elements in a given set.
7.0 Understand the properties of arithmetic and geometric progressions.	**PROGRESSION** 7.1 Define an Arithmetic Progression (A.P) 7.2 Obtain the formula for nth term and the first n terms of an A.P. 7.3 Give examples of the above e.g. find the 20th term of the series e.g. 2+4+6+- - - find also the series of the first 20 terms. 7.4 Define a geometric progression. 7.5 Obtain the formula for the nth term and the first n terms of a geometric series. 7.6 State examples of 7.5 above. E.g. given the sequence, b, 1, 3,..... ... find the 20th term and hence the sum of the 1st 20 terms. 7.7 Define Arithmetic Mean (AM). And Geo metric means (GM). 7.8 Define Convergency of series. 7.9 Define divergency of series.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
8.0 Understand the binomial theorem and its application in the expansion of expressions and in approximations.	**BINOMIAL THEOREM** 8.1 Explain the method of mathematical induction. 8.2 State and prove the binomial theorem for a positive integral index. 8.3 Expand expressions of the forms $(x + y)^2$, $(x^2 - 1/x^2)^6$ applying binomial theorem. 8.4 Find the coefficients of a particular term in the expansion of simple binomial expressions. 8.5 Find the middle term in the expression of binomial expression. 8.6 State the binomial theorem for a rational index. 8.7 Expand expression of the form $(1+x)^{-1}$ $(1-x)^a$, $(1-x)^{-b}$ applying binomial theorem. 8.8 Expand and approximate expressions of the type $(1.001)^n$, $(0.998)^n$, $(1+x)^a$, $(1-x)^b$ to a stated degree of accuracy applying scalar expressions.
9.0 Understand the basic concepts and manipulations of vectors and their application to solution of engineering problems.	**VECTORS** 9.1 State the definitions and representations of vectors. 9.2 Define a position vector. 9.3 Define unit vector. 9.4 Explain scalar multiple of a vector.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	9.5 List the characteristics of parallel vectors.
	9.6 Identify quantities that may be classified as vectors e.g. displacement, velocity, acceleration, force etc.
	9.7 Compute the modulus of any given vector up to 2 and 3 dimensions.
	9.8 State the parallelogram law for addition and subtraction of vectors.
	9.9 Apply the parallelogram law in solving problems including addition and subtraction of vectors.
	9.10 Explain the concept of components of a vector and the meaning of orthogonal components.
	9.11 Resolve a vector into its orthogonal components.
	9.12 List characteristics of coplanar localized vectors.
	9.13 Define the resultant or composition of coplanar vectors.
	9.14 Compute the resultant of coplanar forces acting at a point using algebraic and graphical methods.
	9.15 Apply the techniques of resolution and resultant to the solution of problems involving coplanar forces.

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GENERAL OBJECTIVES		PERFORMANCE OBJECTIVES
		9.16 Apply vectoral techniques in solving problems involving relative velocity. 9.17 State the scalar product of two vectors. 9.18 Compute the scalar product of given vectors. 9.19 Calculate the direction ratios of given vectors. 9.20 Define the cross product or the vector product of two vectors. 9.21 Calculate the angle between two vectors using the scalar product.
10.0	Understand the concept of equations and	**EQUATIONS**
B	methods of solving different types of equations and apply same to engineering problems.	10.1 Explain the concept of equation, i.e. A = where A and B are expressions. 10.2 List different types of equations:- linear, quadratic, cubic etc. 10.3 State examples of linear simultaneous equations with two unknown and simultaneous equations with at least one quadratic equation. 10.4 Apply algebraic and graphical methods in solving two simultaneous equations involving a linear equation and a quadratic equation. 10.5 Apply the algebraic and graphical methods in solving two simultaneous quadratic equations.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	10.6 Define a determinant of nth order. 10.7 Apply determinants of order 2 and 3 in solving simultaneous linear equations.
11.0 Understand the definition, manipulation and applications of trigonometric functions.	**ELEMENTARY TRIGONOMETRY** 11.1 Define basic trigonometric ratios:- sine, cosine and tangent of an angle. 11.2 Derive the other trigonometric ratios:- cosecant, secant and cotangent using the basic trigonometric ratios in 11.1 above. 11.3 Derive identities involving the trigonometricratios of the form $Cos^2Q + Sm^2Q = 1$. $Sec^2Q = 1 + tan^2Q$, etc. 11.4 Derive the compound angle formulae For Sin (A + B), Cos (A + B) and tan (A + B).

COURSE TITLE:- MTH 122 Trigonometry And Analytical Geometry.

LEVEL;- National Diploma: Science Technology & Engineering Programmes

DURATION: 30 Hours

COURSE UNIT: 2.0

GOAL:- This course is intended to give the student basic understanding of trigonometry and analytical geometry and apply same to engineering problems.

GENERAL OBJECTIVES:- On completion of this course, the student

1.0 Understand the manipulation of Trigonometric Formulae and Equations.

2.0 Understand the Concept of Mensuration and its application to Engineering problems.

3.0 Understand the Concept of Analytical Geometry and their applications.

4.0 Know the different forms of conics such as ellipse, parabola and hyperbola.

GENERAL OBJECTIVES		PERFORMANCE OBJECTIVES
1.0 Understand the manipulation of Trigonometric formulae and equations	1.1	On completion of this course, the student should be able to:- **TRIGONOMETRY** Convert sums and differences of trigonometric ratios to products:- $\sin A + \sin B = 2\text{Sm} \frac{(A+B)}{2} \cos \frac{(A-B)}{2}$ $\cos A + \cos B = 2 \cos \frac{(A+B)}{2} \cos \frac{(A-B)}{2}$
	1.2	Prove the sine and cosine formulae of triangles.
	1.3	Solve triangles using the sine and cosine formulae, e.g. the sides a, b, c, of a triangle are 4cm, 5cm and 6cm. Find the angles.
	1.4	Calculate the angles of elevation and depression using trigonometric ratios e.g. from the top of a free 120m high an observer sees a boat 560m away. Calculate the angle of depression.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	1.5 Compute bearings, heights and distances of inaccessible objects and projections e.g. A man walks 3km due N and 3km due N52^{0}W. How far is the man from his starting position? What is his bearing from his original position. 1.6 Derive half angle formulae for Sin, Cos and tan. 1.7 Define inverse circular function. 1.8 Represent inverse circular function graphically. 1.9 Solve problems involving 1.8 above e.g.:- Draw the graph of Cos^{-1} 2Q for Q taking values from O^0 to 90^0 inclusive. 1.10 Apply the concepts in 1.8 above to three dimensional problems.
2.0 Understand the concept of mensuration and its application to engineering problems.	**MENSURATION** 2.1 Explain circular measure. 2.2 State the relation between radians and degrees. 2.3 Derive the formulae for arc length and area of a sector. 2.4 Identify segment and chord of a circle. 2.5 Determine the area of a segment and chord of length of a given circle.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	2.6 Calculate the surface areas and volumes of simple shapes such as cylinder, sphere and cone e.g. A solid sphere has radius 8cm. Calculate its volume. 2.7 Determine the areas and volumes of irregular shapes applying Simpson's rule. 2.8 Apply mid-ordinate rule to determine the areas and volumes apply mid-ordinate rule.
3.0 Understand the concept of Analytical Geometry and their applications.	**ANALYTICAL GEOMETRY** 3.1 Explain two dimensional coordinate systems:- Cartesian and Polar-Coordinate systems. 3.2 Explain plotting and sketching of graph w .r. t the two coordinate systems. 3.3 Relate Cartesian Coordinate to Polar Coordinates. 3.4 Explain the slope of a line in relation to the above concepts in 3.3 above. 3.5 Explain the intercept of a line. 3.6 Derive the formula for the gradient of line passing through two prints. 3.7 Derive the equation of straight line given the gradient and coordinates of a point. 3.8 Reduce a given linear equation to the intercept form x/a + v/b = 1.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	3.9 Determine the coordinates of the point of intersection of two straight lines. 3.10 Define locus. 3.11 Derive the slop-intercept form of the equation of a straight line: $y = mx + C$. 3.12 Derive the point –slope form of the equation of a straight line: $y - y_1 = (x - x_1)$. 3.13 Derive the double – point form of the equations of the straight line; $y - y_1 = \frac{y_2 - y_1}{x_2 - x_1} (x - x_1)$ 3.14 Derive the perpendicular form of the equation of a straight line: $\cos x + y \sin x = p$ 3.15 Give examples of 3.11 to 3.14 above. 3.16 Find the angle (Q) between two lines whose slopes (M_1 and M_2) are known: $Q = \tan^{-1} \frac{M_2 - M_1}{1 + M_1M_2}$ 3.17 Determine the conditions for two lines to be parallel and to be perpendicular. 3.18 Derive the expression for the perpendicular distance from a point to a line. 3.19 Draw a circle 3.20 Derive the equation of a circle with Centre at the origin and radius, r. 3.21 Derive the equation of a circle with centre outside the origin.

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GENERAL OBJECTIVES		PERFORMANCE OBJECTIVES
		3.22 State the general equation of a circle. 3.23 Determine the coordinates of the centre of a circle from a given equation of a circle. 3.24 Draw orthogonal circles. 3.25 Obtain the equations of the tangent and the normal at a point circle. 3.26 List illustrative examples of each of 3.20 to 3.25 above.
4.0	Know the different forms of conics such as ellipse, parabola and hyperbola	**CONICS** 4.1 Define the parabola. 4.2 Derive the standard equation of a parabola $Y^2 = 4ax$. 4.3 State the properties of the parabola. 4.4 Define the focal chord, axis and latus rectum of the parabola. 4.5 Determine the equation of the tangent and normal from a given point to the parabola. 4.6 Solve problems on parabola e.g. Write down the equation of the parabola and state its vertex if the focus is (2, o) and directive x = -2. 4.7 Define an ellipse. 4.8 Derive the equation of an ellipse $x^2/a^2 + y^2/b^2 = 1$. 4.9 State the properties of the ellipse. 4.10 Determine the equation of the tangent and normal to an ellipse from a given point.

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GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	4.11 Define focal chord and axes of ellipse.
	4.12 Solve problems on ellipses e.g. find the length of the axes and the eccentricity for the ellipse $4x^2 + 9y^2 = 36$
	4.13 Define the Hyperbola.
	4.14 Derive the equation of the hyperbola:- $x^2/a^2 - y^2/b^2 = 1$
	4.15 Identify the properties of the hyperbola.
	4.16 Define asymptotes, chord, tangent and normal to a hyperbola.
	4.17 Solve problems on hyperbola e.g. Find the foci and directives for hyperbola $x^2/16 - y^2/9 = 1$.
	4.18 Define rectangular hyperbola.
	4.19 Determine the tangent and normal to the rectangular hyperbola.

COURSE:- MTH 211 Calculus

DURATION:- 30 Hours (2 Hours Lecture)

UNIT:- 2.0

GOAL:- This course is intended to enable the students acquire the basic knowledge of differential and integral Calculus and apply same in solving problems.

GENERAL OBJECTIVES:- On completion of this course the students should be able to:-

1.0 Understand the basic concepts of differential calculus and its application in solving engineering problems.

2.0 Know integration as the reverse of differentiation and its application to engineering problems.

3.0 Understand first order homogeneous linear ordinary differential equations with constant coefficients as applied to simple circuits.

4.0 Understand the basic concepts of partial differentiation and apply same to engineering problems.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	On completion of this course, the students should be able to:-
1.0 Understand the basic concepts of differential calculus and its application in solving engineering problems	**DIFFERENTIAL CALCULUS** 1.1 Define limits with examples. 1.2 State and prove basic theorems on limits. 1.3 Prove that $\lim \frac{\text{Sin } Q}{Q}, \lim \frac{\tan Q}{Q}$ $= 1$ as $Q \longrightarrow 0$ 1.4 Define differentiation as an incremental notation of a function. 1.5 Differentiate a function from first principles. 1.6 Prove the formulae for derivative of functions, function of a function, products and quotient of functions. 1.7 Differentiate simple algebraic, trigonometric, logarithmic, exponential, hyperbolic parametric, inverse and implicit functions.

GENERAL OBJECTIVES		PERFORMANCE OBJECTIVES
		1.9 Apply differentiation to simple engineering and technological problems. 1.10 Explain the rate of change of a function. 1.11 Explain the condition for turning point of a function. 1.12 Distinguish between maximum and minimum value of a function. 1.13 Sketch the graph of a function showing its maximum and minimum and points of inflexion. 1.14 Estimate error quantities from the small increment of a function. 1.15 Determine the tangent to a curve. 1.16 Determine the normal to a curve.
2.0	Know integration as the reverse of differentiation and its application to engineering problems	**INTEGRAL CALCULUS** 2.1 Define integration as the reverse of differentiation. 2.2 Define integration as a limit of summation of a function. 2.3 Distinguish between indefinite and definite integrals. 2.4 Determine the indefinite integral of a function. 2.5 Determine the definite integral of a function. 2.6 Integrate algebraic, logarithmic, trigonometric and exponential simple function.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	2.7 List possible methods of integration. 2.8 Integrate algebraic and trigonometric functions by the substitution method. 2.9 Integrate algebraic and trigonometric functions by parts. 2.10 Integrate algebraic functions by partial fractions. 2.11 Integrate trigonometric and logarithmic functions applying reduction formula. 2.12 State standard forms of some basic integrals. 2.13 Calculate length of arc, area under a curve, area between two curves, volume of revolution, centre of gravity, centre of surface area, second moment and moment of inertia. 2.14 Define Trapezoidal and Simpson's rule as methods of approximating areas under given curves. 2.15 Find the approximate area under a curve applying trapezoidal method. 2.16 Find approximate area under a curve applying Simpson's rule. 2.17 Compare results obtained from Trapezoidal and Simpson's rules with results by direct integration. 2.18 Apply integration to kinematics.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
3.0 Understand first order homogenous linear ordinary differential equations with constant coefficients as to simple circuits.	**DIFFERENTIAL EQUATION** 3.1 Define first order differential equation. 3.2 List order, degree, general solution, boundary or initial conditions and particular solution of differential equations. 3.3 List examples of various types of first order differential equations. 3.4 Define first order homogeneous differential equations. 3.5 List the methods of solving differential equations by separable variables. 3.6 Identify differential equations reducible to homogeneous forms. 3.7 Define an exact differential equation. 3.8 Solve exact differential equations e.g. (a) Show that $(3x^2 + y \text{ Cos } x)dx + (\text{Sin } x - 4y^3)dy = 0$ is an exact differential equation. (b) Find its general solution. 3.10 Determine the solution of differential equations using integrating factors. 3.11 Define linear differential equations of the first order.
4.0 Understand the basic concepts of partial differentiation and apply same to engineering problems.	**PARTIAL DIFFERENTIATION** 4.1 Define partial differentiation. 4.2 List and explain the uses of partial derivatives.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	4.3 Solve problems on partial differential e.g $f(x, y) = x^2 + y^2 - 2xy$ find $\frac{\partial y}{\partial x}$, $\frac{\partial}{\partial y}$
	4.4 Apply partial differential to engineering problems

COURSE UNIT:- 2.0

GOAL:- This course is intended to equip students with knowledge of advanced algebra and its application in engineering and related problems.

GENERAL OBJECTIVES:- On completion of this course, the student will be able to:-

1.0 Understand hyperbolic, exponential and logarithmic functions.

2.0 Understand power, Maclaurin's and Taylor's series with applications to logarithmic, trigonometric and hyperbolic functions.

3.0 Understand the principle of mathematical induction.

4.0 Understand the principles of matrices as applied to engineering problems.

5.0 Understand the principles of vector algebra.

6.0 Understand the concept and application of complex numbers.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
1.0 Understand hyperbolic, exponential and logarithmic functions.	**FUNCTIONS** 1.1 Define hyperbolic sine and cosine functions in terms of exponential functions. 1.2 Draw the hyperbolic graphs for sine, cosine, tangent. 1.3 Transform hyperbolic to trigonometric functions and vice versa. 1.4 Evaluate inverse trigonometric functions. 1.5 Review logarithmic functions. 1.6 Solve problems involving 1.4 above e.g. evaluate $\tan^{-1}(1) - \tan^{-1}(-1)$.
2.0 Understand power, Macclaurin's and Taylor series with applications to logarithmic, trigonometric and hyperbolic functions.	**SERIES** 2.1 State the power series of the form $(1 + x)^n$ 2.2 Evaluate power series in 2.1 above. 2.3 Test for the convergence/divergence of the series in 2.2 above. 2.4 Apply Taylor's formula. 2.5 Derive Macclaurin's series from Taylor's formula. 2.6 Expand functions of the form Cos x, Sin x, tan x, etc. 2.7 Evaluate functions like $\text{Sin } 31^D$ etc. 2.8 Test for convergency/divergency of the series from 2.3 to 2.6 above. 2.9 Test for absolute convergency of the series from 2.3 to 2.6 above. 2.10 State L' Hospital's rule.



GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	2.11 Apply L' Hospital's rule to solve problems in determinants. 2.12 Apply L' Hospital's rule to trigonometric and logarithmic series.
3.0 Understand the principle of mathematical induction.	**PRINCIPLE OF MATHEMATICAL INDUCTION** 3.1 Establish the truth theorem for specific value. 3.2 Explain for some fixed integer, n, the true theorem. 3.3 Explain the true theorem for an integral value (n + 1). 3.4 Explain the application of mathematical induction on Arithmetic Progression. $\sum^{n} r$, Geometric Progression $\sum^{n} r^2$
4.0 Understand the principles of matrices as applied to engineering problems.	**MATRICES** 4.1 Define types of matrices, null, square, rectangular, row. 4.2 Form matrices from sets of linear equations. 4.3 Perform the Arithmetic operations in matrices. Addition, if $A = \begin{matrix} 1 & 2 & 3 \\ 0 & 1 & 4 \end{matrix}$ and $B = \begin{matrix} 2 & 3 & 0 \\ 1 & 2 & 5 \end{matrix}$ Find (i) A + B (ii) A - B 4.4 Obtain the transpose, adjugate, cofactors and the inverse of a matrix.

GENERAL OBJECTIVES		PERFORMANCE OBJECTIVES
		4.5 Describe the use of matrix method to solve linear simultaneous equations. 4.6 Define eigenvector and eigenvalue for a set of matrices. 4.7 Perform the partitioning method for very large matrices. Compute AB, given. $A = \begin{matrix} 2 & 1 & 0 \\ 3 & 2 & 0 \\ 1 & 0 & 1 \end{matrix}$ and $B = \begin{matrix} 1 & 1 & 1 & 0 \\ 2 & 1 & 1 & 0 \\ 2 & 3 & 1 & 2 \end{matrix}$ by partitioning. 4.8 Apply matrices to engineering problems.
5.0	Understand the principles of vector algebra.	**VECTOR ANALYSIS** 5.1 Add, subtract and multiply vector's. 5.2 State the divergence theorem. 5.3 Explain surface integrals as volume integrals. 5.4 State Stoke's theorem. 5.5 Evaluate certain integrals using Stoke's formula. 5.6 Explain vector integration and vector differential, gradient and divergence. 5.7 Apply the analysis to engineering problems.
6.0	Understand the concept and application of complex numbers.	**COMPLEX NUMBERS** 6.1 Explain complex number. 6.2 Explain rectangular and polar forms of complex number.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	6.3 Explain the addition and subtraction of complex numbers. 6.4 Explain the multiplication and division of complex numbers. 6.5 Compute modulus and argument of complex numbers. e.g. $Z = 3 + 4\iota$ find Z , arg.(Z). 6.6 Define a complex number using argand's diagram. 6.7 Add and subtract two complex numbers using argand diagram. 6.8 State De Moivre's theorem for an integer (positive and negative). 6.9 Apply De-Moivre's theorem to A.C. theory. 6.10 Solve equations involving two or more complex numbers e.g. solve the following equation for the real numbers x and y: $(3 + 4\iota)^2 - 2(x + iy) = x + \iota y$ 6.11 Explain rationalization of complex numbers.

COURSE TITLE:- MTH 312. Advanced Calculus

LEVEL:- Higher National Diploma: Engineering Programmes.

DURATION:- 30 Hours

COURSE UNIT:- 2.0

GOAL:- This course is designed to provide students advanced knowledge of calculus necessary for calculations in engineering and related courses.

GENERAL OBJECTIVES:- On completion of this course, the student will be able to:

1.0 Understand Laplace transforms.

2.0 Understand fourier series and apply it to solve engineering problems.

3.0 Understand the methods of solving second order differential equation.

4.0 Understand methods of solving Simultaneous differential equation.

5.0 Understand the methods of solving partial differential equations and their uses.

6.0 Understand the principles of functions of several variables and their uses.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
1.0 Understand Laplace transforms.	**LAPLACE TRANSFORMS** 1.1 Define Laplace transform. 1.2 Obtain Laplace transform of simple functions. 1.3 Define inverse Laplace transform. 1.4 Obtain inverse Laplace transform of simple functions. 1.5 Evaluate some partial fractions with (i) Linear denominator (ii) Quadratic denominator (iii) Cubic denominator. 1.6 Express the derivatives in Laplace transform. 1.7 Express unit step, impulse Driac delta and ramp functions in Laplace transforms. 1.8 Apply Laplace transforms to differential equations e.g. solve by Laplace transform the boundary – value problem. The boundary – value problem

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GENERAL OBJECTIVES		PERFORMANCE OBJECTIVES
		$\frac{\partial \mu}{\partial t} = \frac{4\partial^2 \mu}{\partial x^2}$ $u(O, t) = O, u(3, t) = O,$ $u(x, O) = 20 \text{ Sin } 2\pi x - 6 \text{ Sin } 4\pi x$ 1.9 Apply Laplace transform to suitable engineering problems e.g. use Laplace transforms to find the charge and current at any time in a series circuit having an inductance L, Capacitance C, resistance R, e.m.f E. Treat all cases assuming that the charge and current are zero.
2.0	Understand Fourier series and apply it to solve engineering problems.	**FOURIER SERIES** 2.1 Define Fourier Series. 2.2 Explain periodic function 2.3 Explain non-periodic function. 2.4 Identify even and odd function. 2.5 Explain even and odd functions using graphical representation. 2.6 Explain the characteristics of even and odd function. 2.7 Derive the Fourier coefficients in both polar and rectangular forms. 2.8 Expand simple functions in Fourier series e.g. (i) Simple linear algebraic functions. (ii) Trigonometric and logarithmic functions.

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GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	2.9 Derive the Fourier series for a trigonometric function using the half range approach. 2.10 Expand functions with arbitrary period. 2.11 State Euler's formula. 2.12 Establish a complex Fourier series. 2.13 Evaluate the integration of Fourier series. 2.14 Apply Fourier series to suitable engineering problems.
3.0 Understand the methods of solving second order differential equation.	**SECOND ORDER OF DIFFERENTIAL EQUATION** 3.1 Identify a homogeneous linear equation of 3.2 Establish the second order differential equation with constant coefficients viz: $a\frac{d^2y}{dx^2} + b\frac{dy}{dx} + Cy = O$ 3.3 Find the real and distinct, equal and complex roots for 3.2 above. 3.4 Solve the fundamental system of general solution, given initial values. 3.5 State Cauchy's equation. 3.6 Explain the existence and uniqueness of solution to second order differential equation problems. 3.7 Explain the homogeneous linear equations of higher order constant coefficients. 3.8 Solve non – homogeneous differential equations.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	3.9 Solve simple simultaneous differential equations.
4.0 Understand methods of solving simultaneous linear differential equations.	**SIMULTANEOUS LINEAR DIFFERENTIAL EQUATION** 4.1 Explain linear differential equation. 4.2 Identify special cases of solving first order differential equations. 4.3 Apply the method of exact equations, separable variable to solve differential equation problem. 4.4 Apply knowledge of linear differential equation to suitable engineering problems.
5.0 Understand the methods of solving partial differential	**PARTIAL DIFFERENTIAL EQUATION** 5.1 State partial differential equation of order 2. 5.2 Solve partial differential equation using equations and their separation of variables. uses. 5.3 Apply D'Alembert's solution of the wave equation to partial differential equations. 5.4 Apply the Laplacian concept in polar coordinates to partial equation problems.
6.0 Understand the principles of functions of several variables and their uses.	**FUNCTIONS OF SEVERAL VARIABLES** 6.1 Explain limits and continuity of given functions.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
	6.2 Explain mean – value theorem using total differentials. 6.3 State Taylor's formula for functions of several variables. 6.4 Derive maxima and minima of functions of several variables including possible saddle points. 6.5 Establish the constrained maxima functions of several variable. 6.6 Define a line integral in a plane. 6.7 Explain the path of integral. 6.8 Evaluate line integral problems. 6.9 Define the green's theorem in a plane. 6.10 Apply green's theorem to solve line integral problems. 6.11 Apply double integral to line integral problems. 6.12 Apply change of variables in triple integral. 6.13 Evaluate the differentiation under the integral sign. 6.14 State stoke's formula 6.15 Apply stoke's formula to line integrals in space. 6.16 Apply stoke's formula to suitable engineering problems.

COURSE TITLE: MTH 321 Numerical Methods

LEVEL: Higher National Diploma in Engineering Programmes

DURATION: 30 Hours

COURSE UNIT: 2.0

GOAL: This course is designed to equip the student with knowledge of numerical methods.

GENERAL OBJECTIVES: On completion of this course, the student will be able to:

1.0 Understand the use of numerical methods to solve linear and non-linear equation.

2.0 Understand finite differences.

3.0 Understand interpolation as applied to difference table.

4.0 Understand Numerical Differentiation.

5.0 Understand Numerical Integration.

6.0 Understand Numerical methods of solving first and second order ordinary differential equations.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
1.0 Understand the use of numerical methods to linear and non linear equations.	**LINEAR, NON – LINEAR EQUATIONS** 1.1 Find solutions of linear algebraic equation using Gaussian Elimination method. 1.2 Solve linear algebraic equations using Gauss – Seidel iteration method. 1.3 Apply Newton Raphson iteration formula to non linear equations e.g Find the roots of the equation Cos $x = x^2$ as accurately as your table permit Find the square root of 5 eriat of log = $x^2 - 5$.



GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
2.0 Understand finite Differences.	**FINITE DIFFERENCES** 2.1 Define finite differences. 2.2 Explain the forward differencing tabulation. 2.3 Explain the build-up of errors in a difference table. 2.4 Explain the backward difference table. 2.5 Explain the central difference formula. 2.6 Apply the forward, backward and central difference formula or tables in solving related practical problems.
3.0 Understand inter-polation as applied to difference table.	**INTERPOLATION** 3.1 Define the Newton – Gregory forward difference interpolation formula. 3.2 Evaluate difference table with unequal intervals using divided differences. 3.3 State Lagrange's interpolation formula. 3.4 Evaluate a table using Lagrange interpolation formula.
4.0 Understand Numerical differentiation.	**NUMERICAL DIFFERENTIATION** 4.1 Explain the basic process of numerical differentiation up to the third derivative. 4.2 Explain differentiation based on equal interval interpolation formula. 4.3 Evaluate higher order derivative.

GENERAL OBJECTIVES	PERFORMANCE OBJECTIVES
5.0 Understand Numerical integration.	**NUMERICAL INTEGRATION** 5.1 Explain the Trapezoidal and Simpson's rule. 5.2 Evaluate an integral using the three-eights' rule.
6.0 Understand numerical Methods of solving first and second order ordinary differential equations.	**ORDINARY DIFFERENTIAL EQUATIONS. FIRST SECOND ORDER** 6.1 Explain Runge – Kuta's and Euler's methods. 6.2 Solve the 1st order ordinary differential equations, using Runge – Kuta's method e.g. If $\frac{dy}{dx} = 2x + y$, $Y(0) = 1$, find the approximate value of y (5) using (a) Euler's and (b) Runge – Kuta's method. 6.3 Solve the second order ordinary differential equation using Runge – Kuta's method.

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INTRODUCTION AND GENERAL INFORMATION

The aim and objectives of technical education irrespective of the level it is being provided are outlined in the National Policy on Education (N.P.E) 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 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.

Consequently, technical/vocations institutions in Nigeria in general are expected to play the following three roles:

(i) provisions of vocational courses intended to meet the occupational interest and career needs of the individual.
(ii) Manpower training programmes intended to meet social and economic policy goals of governments, and

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

(iv) It is with reference this background that the role of the current N.B.T.E mathematics cu [152] im for Nigerian polytechnics should be assessed to assisting in attaining the above stated aims and objectives.

SECTION I

This section is to enable the researcher describe the respondents to this questionnaire. Please, thick or fill where appropriate.

SEX: ☐

MALE ☐ FEMALE ☐

HIGHEST LEVEL OF EDUCATIONAL QUALIFICATION

HND ☐ PGD ☐

FIRST DEGREE ☐ SECOND DEGREE ☐

THIRD DEGREE ☐

DEPARTMENT:----------

RANGE OF YOUR LECTURING EXPERIENCE"

(a) 2 years and below

(b) 3 to 5 years

(c) 6 to 10 years

(d) above 15 years

AREA OF SPECIALIZATION

(a) Mathematics

(b) Electrical Engineering

(c) Mechanical Engineering

(d) Chemical Engineering

(e) Civil Engineering

(f) Agricultural Mechanization Engineering

(g) Mineral Resources Engineering

(h) Others (Specify)

SECTION II

Having gone through the N.B.T.E mathematics curriculum for Nigerian polytechnics, kindly respond to this section which attempt to assess degree of attainability of the general objectives, adequacy of the balance and scope of contents, reasonability of the organizational structure of contents and applicability to area of specialization as well as the relevance of instruction objectives of each topic and content.

Based on your perception and vies about this mathematics curriculum, please tick the option which best represents your opinion.

ASSESSMENT OF THE GENERAL OBJECTIVES OF EACH COURSE UNIT

1. The general objectives of Logic and Linear Algebra (MTH III) are
   (a) Fully attainable
   (b) Attainable
   (c) Fairly attainable
   (d) Not attainable
2. The general objectives of algebra and elementary trigonometry (MTHII1) are
   (a) Fully attainable
   (b) Attainable
   (c) Fairly attainable
   (d) Not attainable
3. The general objectives of Trigonometry and Analytical Geometry (MTH122) are
   (a) Fully attainable

(b) Attainable

(c) Fairly attainable

(d) Not attainable

4. The general objectives of Calculus (MTH 211) are

(a) Fully attainable

(b) Attainable

(c) Fairly attainable

(d) Not attainable

5. The general objectives of Advanced Algebra (MTH311) are

(a) Fully attainable

(b) Attainable

(c) Fairly attainable

(d) Not attainable

6. The general objectives of Advanced Calculus (MTH312) are

(a) Fully attainable

(b) Attainable

(c) Fairly attainable

(d) Not attainable

7. The general objectives of Numerical Methods (MTH321) are

(a) Fully attainable

(b) Attainable

(c) Fairly attainable

(d) Not attainable

ASSESSMENT OF BALANCE AND SCOPE OF CONTENT OF EACH COURSE UNIT

8. The balance and scope of the contents of Logic and Linear Algebra (MTH111) are

(a) Very adequate

(b) Adequate

(c) Fairly adequate

(d) Not adequate

9. The balance and scope of the contents of Algebra and Elementary Trigonometry (MTH 112) are

(a) Very adequate

(b) Adequate

(c) Fairly adequate

(d) Not adequate

10. The balance and scope of the contents of Trigonometry and Analytical Geometry (MTH122) are

(e) Very adequate

(f) Adequate

(g) Fairly adequate

(e) Not adequate

11. The balance and scope of the contents of Calculus (MTH211) are

(a) Very adequate

(b) Adequate

(c) Fairly adequate

(d) Not adequate

12. The balance and scope of the contents of Advanced Algebra (MTH311) are

(a) Very adequate

(b) Adequate

(c) Fairly adequate

(d) Not adequate

13. The balance and scope of the contents of Advanced Calculus (MTH312)

(a) Very adequate

(b) Adequate

(c) Fairly adequate

(d) Not adequate

14. The balance and scope of the contents of Numerical Methods (MTH321) are

(a) Very adequate

(b) Adequate

(c) Fairly adequate

(d) Not adequate

ASSESSMENT OF THE REASONABILITY OF EACH COURSE UNIT ORGANISATIONAL STRUCTURE

15. The organisational structural of the contents of Logic and Linear Algebra (MTH 11) are

(a) Very reasonable

(b) Reasonable

(c) Fairly reasonable

(d) Not reasonable

16. The organizational structure of the contents of Algebra and Elementary Trigonometry (MTH 112) are

(a) Very reasonable

(b) Reasonable

(c) Fairly reasonable

(d) Not reasonable

17. The organization structure of the contents of Trigonometry and Analytical Geometry (MTH 122) are

(a) Very reasonable

(b) Reasonable

(c) Fairly reasonable

(d) Not reasonable

18. The organizational structure of the contents calculus (MTH211) are
    (a) Very reasonable
    (b) Reasonable
    (c) Fairly reasonable
    (d) Not reasonable
19. The organizational structure of the contents of Advanced Algebra (MTH311) are
    (a) Very reasonable
    (b) Reasonable
    (c) Fairly reasonable
    (d) Not reasonable
20. The organizational structure of the contents of Advanced Calculus (MTH 312) are
    (a) Very reasonable
    (b) Reasonable
    (c) Fairly reasonable
    (d) Not reasonable
21. The organizational structure of the contents of Numerical Methods (MTH321) are
    (a) Very reasonable
    (b) Reasonable
    (c) Fairly reasonable
    (d) Not reasonable

NOTE: ITEMS 22 TO 28 IS NOT MEANT FOR MATHEMATICS LECTURERS

ASSESSMENT OF THE APPLICABILITY OF EACH COURSE UNIT TO YOUR AREA OF SPECIALIZATION

22. The contents of Logic and Linear Algebra (MTH111) are
    (a) Highly applicable

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(b) Applicable

(c) Fairly applicable

(d) Not applicable

to my area of specialization

23. The content of Algebra and Elementary Trigonometry (MTH112) are

(a) Highly applicable

(b) Applicable

(c) Fairly applicable

(d) Not applicable,

to my area of specialization

24. The contents of Trigonometry and Analytical Geometry (MTH122) are

(a) Highly applicable

(b) Applicable

(c) Fairly applicable

(e) Not applicable

to my area of specialization

25 The contents of Calculus (MTH 211) are

(a) Highly applicable

(b) Applicable

(c) Fairly applicable

(d) Not applicable

to my area of specialization

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26. The contents of Advanced Algebra (MTH311) are

(a) Highly applicable

(b) Applicable

(c) Fairly applicable

(d) Not applicable

to my area of specialization

27. The contents of Advanced Calculus (MTH 312) are

(a) Highly applicable

(b) Applicable

(c) Fairly applicable

(d) Not applicable

to my area of specialization

28. The contents of Numerical Methods (MTH 321) are

(a) Very reasonable

(b) Reasonable

(c) Fairly reasonable

(d) Not reasonable not applicable

to my area of specialization

ASSESSMENT OF THE RELEVANCE OF THE INSTRUCTIONAL OBJECTIVE OF EACH TOPIC

29. The instructional objectives of "Logic" under the course of unit Logic and Linear Algebra (MTH 111) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

30. The instructional objectives of "Permutations and Combinations" in the course unit Logic and Linear Algebra (MTH111) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

31. The instructional objectives of "Binomial Theorem" in the course unit Logic and Linear Algebra (MTh111) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

32. The instructional objectives of "Matrices and Determinants" in the course unit Logic and Linear Algebra (MTH111) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

33. The instructional objectives of "Indices" the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

34. The instructional objectives of "Logarithm and Surds" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

35. The instructional objectives of "Graphs" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

36. The instructional objectives of "Theory of Quadratic Equations" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

37. The instructional objectives of "Permutations and Combinations" in the course unit Algebra and Elementary Trigonometry (MTH112) is

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

38. The instructional objectives of "Set Theory" in the course unit Algebra and Elementary Trigonometry (MTH112) is

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

39. The instructional objectives of "Progressions" in the course unit Algebra and Elementary Trigonometry (MTH112) is

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

40. The instructional objectives of "Binomial Theorem" in the course unit Algebra and Elementary Trigonometry (MTH112) is
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit

41. The instructional objectives of "Vectors" in the course unit Algebra and Elementary Trigonometry (MTH112) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit

42. The instructional objectives of "Equations" in the course unit Algebra and Elementary Trigonometry (MTH112) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit

43. The instructional objectives of "Elementary Trigonometry" in the course unit Algebra and Elementary Trigonometry (MTH112) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit

44. The instructional objectives of "Trigonometry" in the course unit Trigonometry and Analytical Geometry (MTH122) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit
45. The instructional objectives of "Menstruation" in the course e unit Trigonometry and Analytical Geometry (MTH122) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit
46. The instructional objectives of "Analytical Geometry" in the course unit Trigonometry and Analytical Geometry (MTH122) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit
47. The instructional objectives of "Conics" in the course unit Trigonometry and Analytical Geometry (MTH122) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit

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48. The instructional objectives of "Differential Calculus" in the course unit calculus (MTH211) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit
49. The instructional objectives of "Integral Calculus" in the course unit calculus (MTH211) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit
50. The instructional objectives of "Differential Equations" in the course unit calculus (MTH211) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit
51. The instructional objectives of "Partial Differentiation" in the course unit calculus (MTH211) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the general objectives of the course unit

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52. The instructional objectives of "Functions" in the course unit Advanced Algebra (MTH311) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

53. The instructional objectives of "Series" in the course unit Advanced Algebra (MTH311) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

54. The instructional objectives of "Principle of Mathematical Induction" in the course unit Advanced Algebra (MTH311) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

55. The instructional objectives of "Matrices" in the course unit Advanced Algebra (MTH311) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

56. The instructional objectives of "Vector Analysis" in the course unit Advanced Algebra (MTH311) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

57. The instructional objectives of "Complex Numbers" in the course unit Advanced Algebra (MTH311) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

58. The instructional objectives of "Laplace" in the course unit Advanced Algebra (MTH312) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit

59. The instructional objectives of "Fourier series " in the course unit Advanced Algebra (MTH312) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(e) Not relevant

to the general objectives of the course unit

60. The instructional objectives of "second order of differential Equations" in the in the course unit Advanced Algebra (MTH312) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objective of the course unit

61. The institution objectives of "Simultaneous Linear Differential Equations" in the course unit Advanced calculus (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objective of the course unit.

62. The institution objectives of "Partial Differential equations" in the course unit Advanced calculus (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit.

63. The institution objectives of "Functions of Several Variables" in the course unit Advanced calculus (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit.

64. The institution objectives of "Linear, Non- Linear Equations" in the course unit Numerical Methods (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit.

65. The institution objectives of "Finite Differences" in the course unit Numerical Methods" (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit.

66. The institution objectives of "Interpolation" in the course unit Numerical Methods (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit.

67. The institution objectives of "Numerical Differentiation" in the course unit Numerical Methods (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit.

68. The institution objectives of "Numerical Integration" in the course unit Numerical Methods (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit.

69. The institution objectives of "Ordinary Differential Equations. First, second order" in the course unit Numerical Methods (MTH 321) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the general objectives of the course unit.

ASSESSMENT OF THE RELEVANCE OF EACH TOPIC OF EACH COURSE UINT.

70. The contents of "Logic" in the course unit Logic and linear Algebra (MTH111) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

71. The contents of "Permutations and Combinations" in the course unit Logic and Linear Algebra (MTH111) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit

72. The contents of "Binomial Theory" in the course unit Logic and Linear Algebra (MTH111) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the objectives of the course unit

73. The contents of "Matrices and Determinants" in the course unit Logic and Linear Algebra (MTH111) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the objectives of the course unit.

74. The contents of "Indices" in the course unit Algebra and elementary Trigonometry (MTH112) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the objectives of the course unit.

75. The contents of "Logarithm and Surds" in the course unit Algebra and Elementary Trigonometry (MTH112) are
    (a) Highly relevant
    (b) Relevant
    (c) Fairly relevant
    (d) Not relevant
    to the objectives of the course unit.

The contents of "Graphs" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

76. The contents of "Theory of Quadratic Equations" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

77. The contents of "Permutations and Combinations" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

78. The contents of "Set Theory" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

79. The contents of "Progressions" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

80. The contents of "Binomial Theory" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

81. The contents of "Vectors" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

82. The contents of "Equations" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

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84. The contents of "Elementary Trigonometry" in the course unit Algebra and Elementary Trigonometry (MTH112) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

85. The Contents of "Trigonometry" in the course unit Trigonometry and Analytical Geometry (MTH122) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

86. The Contents of "Mensuration" in the course unit Trigonometry and Analytical Geometry (MTH122) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

87. The Contents of "Analytical Geometry" in the course unit Trigonometry and Analytical Geometry (MTH122) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

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88. The Contents of "Conics " in the course unit Trigonometry and Analytical Geometry (MTH122) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

89. The Contents of "Differential calculus" in the course unit calculus (MTH 211) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

90. The contents of "Integral Calculus" in the course unit calculus (MTH 211) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

91. The Contents of "Different Equations" in the course unit Calculus (MTH211) are

(a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

92. The contents of "Partial Differentiation" in the course unit calculus (MTH 211) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

93. The contents of "Functions" in the course unit Advanced Algebra (MTH 311) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

94. The contents of "Series" in the course unit Advanced Algebra (MTH 311) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

95. The contents of "Principle of Mathematical Induction" in the course unit Advanced Algebra (MTH 311) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

96. The contents of "Matrices" in the course unit Advanced Algebra (MTH 311) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

97. The contents of "Vector Analysis" in the course unit Advanced Algebra (MTH 311) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

98. The contents of "Complex Numbers" in the course unit Advanced Algebra (MTH 311) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

99. The contents of "Laplace Transforms" in the course unit Advanced Calculus (MTH 312) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

100. The contents of "Fourier Series" in the course unit Advanced Calculus (MTH 312) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

101. The contents of "Second Order of differential Equations" in the course unit Advanced calculus (MTH 312) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

102. The contents of "Simultaneous Linear Differential Equations" in the course unit Advanced calculus (MTH 312) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

103. The contents of "Partial Differential Equations" in the course unit Advanced calculus (MTH 312) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

104. The contents of "Functions of several Variables" in the course unit Advanced calculus (MTH 312) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

105. The contents of "Linear, Non-Linear Equations" in the course unit Numerical methods are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

d) Not relevant

to the objectives of the course unit.

106. The contents of "Finite Difference" in the course unit Numerical methods are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

107. The contents of "Interpolation" in the course unit Numerical methods (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

108. The contents of "Numerical Differentiation" in the course unit Numerical methods (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

109. The contents of "Numerical Integration" in the course unit Numerical methods (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

110. The contents of "Ordinary Differential, Equations. First, second order " in the course unit Numerical methods (MTH 321) are

a) Highly relevant

(b) Relevant

(c) Fairly relevant

(d) Not relevant

to the objectives of the course unit.

KASUM IER

SECTION III

POLYTECHNIC MATHEMATICS CURRICULUM EVALUATION CHECKLIST FOR THE ASSESSMENT OF THE ADEQUACY OF LEARNING FACILITIES.

INSTITUTIONS	FACILITIES	NUMBER REQUIRED	NUMBER AVAILABLE
KADUNA POLYTECHNIC			
COLLEGE OF TECHNOLOGY, YABA			
INSTITUTE OF MANAGEMENT AND TECHNOLOGY, ENUGU.			
AUCHI POLYTECHNIC			

SECTION IV

POLYTECHNIC MATHEMATICS CURRICULUM EVALUATION CHECKLIST FOR THE ASSESSMENT OF THE ADEQUACY OF MATHEMATICS LECTURERS.

INSTITUTIONS	RANKS	NUMBER REQUIRED	NUMBER AVAILABLE
Kaduna polytechnic	Chief lecturer Principal lecturer Senior lecturer Lecturer I Lecturer II Lecturer III Assistant lecturer		
College of Technology, Yaba	Chief lecturer Principal lecturer Senior lecturer Lecturer I Lecturer II Lecturer III Assistant lecturer		
Institute of Management and Technology, Enugu.	Chief lecturer Principal lecturer Senior lecturer Lecturer I Lecturer II Lecturer III Assistant lecturer		
Auchi Polytechnics	Chief lecturer Principal lecturer Senior lecturer Lecturer I Lecturer II Lecturer III Assistant lecturer		

APPENDIX C

MATHEMATICS LECTURERS RESPONSES TO QUESTIONNAIRE OF RESEARCH INSTRUMENT.

ITEM No.	OPTIONS				TOTAL
	A	B	C	D	
1	4	11	39	2	56
2	2	8	42	4	56
3	6	14	34	2	56
4	4	6	40	6	56
5	2	10	35	9	56
6	-	10	45	1	56
7	3	9	34	10	56
TOTAL	**21**	**68**	**269**	**34**	**392**
8	10	34	9	3	56
9	6	40	4	6	56
10	2	34	14	6	56
11	4	42	8	2	56
12	5	39	10	2	56
13	1	45	10	-	56
14	10	35	9	2	56
TOTAL	**38**	**269**	**64**	**21**	**392**
15	9	38	9	-	56
16	6	40	9	1	56
17	10	36	8	2	56
18	5	42	7	2	56
19	10	35	8	3	56

20	5	30	11	10	56
21	7	42	7	-	56
TOTAL	**52**	**263**	**59**	**18**	**392**
22	-	-	-	-	-
23	-	-	-	-	-
24	-	-	-	-	-
25	-	-	-	-	-
26	-	-	-	-	-
27	-	-	-	-	-
28	-	-	-	-	-
TOTAL	-	-	-	-	-
29	4	37	10	5	56
30	3	42	8	3	56
31	3	42	8	-	56
32	8	39	6	3	56
33	4	39	11	2	56
34	2	42	8	4	56
35	6	34	14	2	56
36	6	40	6	4	56
37	9	35	10	2	56
38	1	45	10	-	56
39	10	34	9	3	56
40	6	40	6	4	56
41	6	34	14	2	56
42	4	42	8	2	56
43	5	39	10	2	56
44	4	41	10	1	56

45	10	39	5	2	56
46	9	38	9	-	56
47	10	36	8	2	56
48	7	42	7	-	56
49	10	30	11	5	56
50	10	35	8	3	56
51	9	40	6	1	56
52	10	38	7	1	56
53	6	45	5	-	56
54	3	42	9	2	56
55	5	40	8	3	56
56	6	40	6	4	56
57	4	42	8	2	56
58	6	42	8	-	56
59	7	36	11	2	56
60	10	34	9	3	56
61	6	40	9	1	56
62	8	39	9	-	56
63	9	38	7	2	56
64	7	40	7	2	56
65	5	42	8	1	56
66	8	38	9	1	56
67	6	45	5	-	56
68	7	40	8	1	56
69	8	42	6	-	56
TOTAL	**267**	**1609**	**341**	**79**	**2296**
70	10	34	9	3	56
71	6	40	9	1	56

72	8	39	8	1	56
73	9	38	7	2	56
74	7	42	7	-	56
75	5	42	7	2	56
76	8	38	9	1	56
77	6	45	5	-	56
78	7	40	8	1	56
79	6	42	8	-	56
80	7	36	11	2	56
81	5	40	8	3	56
82	9	40	6	1	56
83	7	42	8	4	56
84	10	39	5	2	56
85	9	36	10	2	56
86	9	35	10	2	56
87	2	42	8	4	56
88	4	39	11	2	56
89	9	38	9	11	56
90	6	40	9	1	56
91	5	42	7	2	56
92	7	42	7	-	56
93	10	36	8	2	56
94	5	39	10	2	56
95	6	40	6	4	56
96	10	34	9	3	56
97	9	35	10	2	56
98	6	34	14	2	56
99	6	40	6	4	56
100	6	41	8	1	56

101	5	39	10	2	56
102	7	36	11	2	56
103	6	42	8	-	56
104	4	43	8	1	56
105	6	45	5	-	56
106	10	35	8	3	56
107	7	42	7	-	56
108	10	36	8	2	56
109	4	44	70	1	56
110	4	42	8	2	56
TOTAL	**282**	**1614**	**335**	**65**	**2296**

APPENDIX D

SCORES OF MATHEMATICS LECTURERS RESPONSES TO QUESTIONNAIRE OF THE RESEARCH INSTRUMENT.

ITEM NO	OPTIONS				TOTAL
	a	B	C	D	
1	16	33	78	2	129
2	8	24	84	4	120
3	24	36	68	2	130
4	16	18	80	6	120
5	8	30	70	9	117
6	0	30	90	1	121
7	12	27	68	10	117
TOTAL	**84**	**198**	**538**	**34**	**854**
8	40	102	18	3	163
9	24	120	8	6	158
10	8	102	28	6	144
11	16	126	16	2	160
12	20	117	20	2	159
13	4	135	20	0	159
14	40	105	18	2	165
TOTAL	**152**	**807**	**128**	**21**	**1108**
15	96	114	18	0	228
16	24	120	18	1	163
17	40	108	16	2	166
18	20	126	14	2	162

19	40	105	16	3	164
20	20	90	22	10	142
21	28	126	14	0	168
TOTAL	**268**	**789**	**118**	**18**	**1193**
29	16	111	20	5	152
30	12	126	16	3	157
31	12	135	16	0	163
32	32	117	12	3	164
33	16	117	22	2	157
34	8	126	16	2	154
35	24	102	28	2	156
36	24	120	12	4	163
37	36	105	20	2	163
38	4	135	20	0	159
39	40	102	18	3	163
40	24	120	12	4	160
41	24	102	24	2	152
42	16	126	16	2	160
43	20	117	20	2	159
44	16	123	20	1	160
45	40	117	10	2	169
46	36	108	16	0	160
47	40	108	16	2	166
48	28	126	14	0	168
49	40	90	22	5	157
50	40	105	16	3	164
51	36	120	12	1	169
52	24	135	10	1	170

53	12	126	18	0	156
54	20	120	16	2	158
55	24	120	12	3	159
56	16	126	16	4	162
57	24	126	16	2	168
58	28	108	22	0	158
59	40	102	18	2	162
60	24	120	18	3	165
61	32	117	18	1	168
62	36	114	14	0	164
63	28	120	14	2	164
64	20	126	16	2	164
65	32	114	18	1	165
66	24	135	10	1	170
67	28	120	16	0	164
68	32	126	12	1	171
TOTAL	**1068**	**4827**	**676**	**78**	**6649**
70	40	102	18	3	163
71	24	120	18	1	163
72	32	117	16	1	166
73	36	114	14	2	166
74	28	126	14	0	168
75	20	126	14	2	162
76	32	114	18	1	165
77	24	135	10	0	169
78	28	120	16	1	165
79	24	126	16	0	166
80	28	108	22	2	160

81	20	120	16	3	159
82	36	120	12	1	169
83	28	126	14	4	172
84	40	117	10	2	169
85	36	108	18	2	164
86	36	105	20	2	163
87	8	126	16	4	154
88	16	117	22	2	157
89	36	114	18	11	179
90	24	120	18	1	163
91	20	126	14	2	162
92	28	126	14	0	168
93	40	108	16	2	166
94	20	117	20	2	159
95	24	120	12	4	160
96	40	105	18	3	163
97	36	102	20	2	163
98	24	120	28	2	156
99	24	102	12	4	160
100	24	123	16	1	164
101	20	117	20	2	159
102	28	108	22	2	160
103	24	126	16	0	166
104	16	129	16	1	162
105	24	135	10	0	169
106	40	105	16	3	164
107	28	126	14	0	168
108	40	108	16	2	166
109	16	132	14	1	163

110	16	126	16	3	160
TOTAL	**1128**	**4842**	**670**	**80**	**6720**

APPENDIX E

ENGINEERING COURSES/ SUBJECTS LECTURERS RESPONSES TO QUESTIONNAIRE OF THE RESEARCH INSTRUMENT.

ITEM	OPTIONS				
NO.	a	b	c	d	TOTAL
1	9	32	111	6	158
2	6	24	119	9	158
3	16	40	95	7	158
4	13	16	125	4	158
5	12	19	120	7	158
6	20	28	100	10	158
7	7	26	117	8	158
TOTAL	**83**	**185**	**787**	**51**	**1106**
8	9	121	23	5	158
9	8	130	16	4	158
10	10	109	32	7	158
11	12	113	28	5	158
12	6	129	19	4	158
13	13	120	15	10	158
14	7	125	20	6	158
TOTAL	**65**	**847**	**153**	**41**	**1106**
15	10	117	28	3	158
16	12	120	24	2	158
17	6	129	22	1	158
18	12	130	16	0	158

19	13	125	20	0	158
20	9	121	27	1	158
21	6	140	12	-	158
TOTAL	**65**	**847**	**153**	**41**	**1106**
22	8	121	27	2	158
23	5	130	22	1	158
24	7	125	22	4	158
25	17	129	10	2	158
26	12	140	6	0	158
27	19	126	10	3	158
28	10	103	40	5	158
TOTAL	**78**	**874**	**137**	**17**	**1106**
29	5	22	129	2	158
30	7	25	123	3	158
31	6	20	130	2	158
32	9	23	125	1	158
33	14	35	108	1	158
34	9	30	117	2	158
35	7	20	131	0	158
36	-	17	141	0	158
37	10	30	116	2	158
38	9	29	119	1	158
39	7	35	114	2	158
40	8	28	120	2	158
41	10	30	117	1	158
42	6	27	125	0	158
43	9	20	128	1	158

44	2	25	131	0	158
45	0	18	140	0	158
46	4	28	126	0	158
47	0	19	139	0	158
48	14	35	105	4	158
49	6	32	119	1	158
50	3	30	124	1	158
51	7	20	130	1	158
52	10	29	118	1	158
53	6	30	122	0	158
54	7	25	123	3	158
55	9	23	125	1	158
56	14	35	108	1	158
57	10	30	116	2	158
58	9	30	117	2	158
59	5	22	129	2	158
60	7	25	123	3	158
61	9	23	125	1	158
62	10	30	116	2	158
63	7	21	130	0	158
64	7	19	129	3	158
65	8	28	120	2	158
66	10	27	119	2	158
67	7	35	114	2	158
68	10	28	119	1	158
69	9	29	120	0	158
TOTAL	**306**	**1087**	**5030**	**55**	**6478**

200

70	9	120	28	1	158
71	7	114	35	2	158
72	10	119	27	2	158
73	7	129	19	3	158
74	8	120	28	2	158
75	10	116	30	2	158
76	9	125	23	1	158
77	7	123	25	3	158
78	10	116	30	2	158
79	7	123	25	3	158
80	7	130	20	1	158
81	6	119	32	1	158
82	4	126	28	0	158
83	5	129	22	2	158
84	7	123	25	3	158
85	6	130	20	2	158
86	9	125	23	1	158
87	7	131	20	0	158
88	10	116	30	2	158
89	8	120	28	2	158
90	14	105	33	6	158
91	4	126	28	0	158
92	64	119	32	1	158
93	7	130	20	1	158
94	9	128	20	1	158
95	7	114	35	2	158
96	10	116	30	2	158
97	10	117	28	3	158
98	6	129	21	2	158

99	9	121	27	1	158
100	8	130	16	4	158
101	7	125	20	6	158
102	7	117	26	8	158
103	9	121	23	5	158
104	7	128	17	6	158
105	8	130	20	0	158
106	6	125	27	0	158
107	9	119	29	1	158
108	7	130	19	2	158
109	10	120	25	3	158
110	9	128	20	1	158
TOTAL	**322**	**5032**	**1034**	**90**	**6478**

APPENDIX F

SCORES OF ENGINEERING COURSES/SUBJECTS LECTURERS RESPONSES TO QUESTIONNAIRE OF THE RESEARCH INSTRUMENT.

ITEM	OPTIONS				
NO.	a	b	c	d	TOTAL
1	36	96	222	6	360
2	24	72	238	9	343
3	64	120	190	7	381
4	52	48	250	4	354
5	48	57	240	7	352
6	80	84	200	10	374
7	28	78	234	8	348
TOTAL	**332**	**355**	**1574**	**51**	**2512**
8	36	363	46	5	450
9	32	390	32	4	458
10	40	327	64	7	438
11	48	339	56	5	448
12	24	387	38	4	453
13	52	360	30	10	452
14	28	375	40	6	449
TOTAL	**260**	**2541**	**306**	**41**	**3148**
15	40	351	56	3	450
16	48	360	48	2	458
17	24	387	44	1	456
18	48	390	32	0	470
19	52	375	40	0	467
20	36	363	54	1	454
21	24	420	24	0	468

TOTAL	272	2646	298	7	3223
22	32	363	54	2	451
23	20	390	44	1	455
24	28	375	44	4	451
25	68	387	20	2	477
26	48	420	12	0	480
27	76	378	20	3	477
28	40	309	80	5	434
TOTAL	312	2622	274	17	3225
29	20	66	258	2	346
30	28	75	246	3	352
31	24	60	260	2	346
32	36	69	250	1	356
33	56	105	216	1	378
34	36	90	234	2	362
35	28	60	262	0	350
36	0	51	282	0	333
37	40	90	232	2	364
38	36	87	238	1	362
39	28	105	228	2	363
40	32	84	240	2	358
41	40	90	234	1	365
42	24	81	250	0	355
43	36	60	256	1	353
44	8	75	262	0	345
45	0	54	280	0	334
46	16	84	252	0	353
47	0	57	278	0	335
48	56	105	210	4	375

49	24	96	238	1	359
50	12	90	248	1	351
51	28	60	260	1	3349
52	40	87	236	1	364
53	24	90	244	0	358
54	28	75	246	3	352
55	36	69	250	1	356
56	56	105	216	1	378
57	40	90	232	2	364
58	36	90	234	2	362
59	20	66	258	2	346
60	28	75	246	3	352
61	36	69	250	1	356
62	40	90	232	2	364
63	28	63	260	0	351
64	28	57	255	3	346
65	32	84	240	2	358
66	40	81	238	2	361
67	28	105	224	2	359
68	40	84	238	1	363
69	36	87	240	0	363
TOTAL	**1224**	**3261**	**10056**	**55**	**14596**
70	36	360	56	1	453
71	28	342	70	2	442
72	40	357	54	2	453
73	28	387	38	3	456
74	32	360	56	2	450
75	40	348	60	2	450
76	36	375	46	1	458

KASHIM IBRAHIM LIBRARY

77	28	369	50	3	450
78	40	348	60	2	450
79	28	369	50	3	450
80	28	390	40	1	459
81	24	357	64	1	446
82	16	378	56	0	450
83	20	387	44	2	453
84	28	369	50	3	450
85	24	390	40	2	456
86	36	375	46	1	458
87	28	393	40	0	461
88	40	348	60	2	450
89	32	360	56	2	450
90	56	315	66	6	443
91	16	378	56	0	450
92	24	357	64	1	446
93	28	390	40	1	459
94	36	384	40	1	461
95	28	342	70	2	442
96	40	348	60	2	450
97	40	351	56	3	450
98	24	387	42	2	455
99	36	363	54	1	454
100	32	390	32	4	458
101	28	375	40	6	449
102	28	351	52	8	439
103	36	3636	40	5	450
104	28	384	34	6	452
105	32	390	40	0	462

106	24	375	54	0	453
107	36	357	58	1	452
108	28	390	38	2	458
109	40	360	50	3	453
110	36	384	40	1	461
TOTAL	**1288**	**15096**	**2068**	**90**	**18542**

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APPENDIX G

RESPONDENT MEAN OPINION SCORES PER CURRICULUM ITEM

C. I	ML Scores	ECL Scores		C.I	ML Scores	ECL Scores
C_1	2.30	2.28		C_{56}	2.84	2.39
C_2	2.14	2.17		C_{57}	2.89	2.30
C_3	2.32	2.41		C_{58}	3.00	2.29
C_4	2.14	2.24		C_{59}	2.82	2.19
C_5	2.09	2.23		C_{60}	2.89	2.23
C_6	2.16	2.37		C_{61}	2.95	2.25
C_7	2.09	2.20		C_{62}	3.00	2.30
C_8	2.91	2.85		C_{63}	2.93	2.22
C_9	2.82	2.90		C_{64}	2.93	2.19
C_{10}	2.57	2.77		C_{65}	2.93	2.27
C_{11}	2.86	2.84		C_{66}	2.95	2.28
C_{12}	2.84	2.87		C_{67}	3.04	2.27
C_{13}	2.84	2.86		C_{68}	2.93	2.30
C_{14}	2.95	2.84		C_{69}	3.05	2.30
C_{15}	407	2.85		C_{70}	2.91	2.87
C_{16}	2.91	2.90		C_{71}	2.91	2.80
C_{17}	2.96	2.89		C_{72}	2.96	2.87
C_{18}	2.89	2.97		C_{73}	2.96	2.89
C_{19}	2.93	2.96		C_{74}	3.00	2.85
C_{20}	2.54	2.87		C_{75}	2.89	2.85
C_{21}	3.00	2.96		C_{76}	2.9	2.90
C_{22}	-	2.85		C_{77}	3.02	2.85
C_{23}	-	2.88		C_{78}	2.95	2.85
C_{24}	-	2.85		C_{79}	2.96	2.85
C_{25}	-	3.02		C_{80}	2.86	2.91
C_{26}	-	3.04		C_{81}	2.84	2.82

C_{27}	-	3.02	C_{82}	3.02	2.85
C_{28}	-	2.75	C_{83}	3.07	2.87
C_{29}	2.71	2.19	C_{84}	3.02	2.85
C_{30}	2.71	2.23	C_{85}	2.93	2.89
C_{31}	2.91	2.19	C_{86}	2.91	2.90
C_{32}	2.93	2.25	C_{87}	2.75	2.92
C_{33}	2.60	2.39	C_{88}	2.80	2.85
C_{34}	2.75	2.29	C_{89}	3.20	2.85
C_{35}	2.79	2.22	C_{90}	2.91	2.80
C_{36}	2.86	2.11	C_{91}	2.89	2.85
C_{37}	2.91	2.30	C_{92}	3.00	2.82
C_{38}	2.84	2.29	C_{93}	2.96	2.91
C_{39}	2.91	2.30	C_{94}	2.84	2.92
C_{40}	2.86	2.27	C_{95}	2.86	2.80
C_{41}	2.71	2.31	C_{96}	2.91	2.85
C_{42}	2.86	2.25	C_{97}	2.91	2.85
C_{43}	2.84	2.23	C_{98}	2.79	2.85
C_{44}	2.86	2.18	C_{99}	2.91	2.87
C_{45}	3.02	2.11	C_{100}	2.93	2.90
C_{46}	2.86	2.23	C_{101}	2.84	2.84
C_{47}	2.96	2.12	C_{102}	2.86	2.78
C_{48}	3.00	2.37	C_{103}	2.96	2.85
C_{49}	2.80	2.27	C_{104}	2.86	2.86
C_{50}	2.93	2.22	C_{105}	3.02	2.92
C_{51}	3.02	2.21	C_{106}	2.93	2.87
C_{52}	3.02	2.30	C_{107}	3.00	2.86
C_{53}	3.04	2.27	C_{108}	2.96	2.90
C_{54}	2.79	2.79	C_{109}	2.91	2.87
C_{55}	2.82	2.25	C_{110}	2.86	2.92