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## STRATEGIC MANAGEMENT OF SCIENCE, TECHNOLOGY AND MATHEMATICS EDUCATION (STME)

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### ABSTRACT

*This paper provides a general overview of strategic management of science, technology and mathematics education, (STME) in developing countries. It examines policy statements on science, technology and mathematics education (STME) and summarises management processes required for the strategic management of this form of education. The paper concludes with a number of recommendations for improving the quality of this form of education in developing countries.*

### Introduction

Scientific, technological and Mathematical (STME) education is acknowledged as the magic wand required for the breeding of scientists and technical manpower needed for accelerated industrial development worldwide. Every nation strives to improve its industrial production capacity, hence the huge investment in scientific, technological and mathematical education (STME). The human capital theorists (such as T. W. Schultz, M. Bowman and Becker) identified a link between investments in education and economic growth. They argued that without the required stock of skills,

physical capital accumulation will not be able to accelerate economic growth. This implies that it is the breeding and employment of adequate and appropriate technical manpower that can accelerate economic development.

In most developing countries, a lot of emphasis is put on science, technology and mathematics education (STM). Most national policies on education prescribe a 6-3-3-4 educational system, i.e. six-year duration for primary education, three for Junior Secondary School, three for Senior Secondary School and four for Tertiary or higher education. These policies place emphasis on the teaching of science, technology and mathematics education. In Nigerian Secondary Schools, for example, the core subjects at the J.S.S. level include Mathematics, Integrated Science and Introductory Technology (i.e. Pre-vocational subjects). In the Senior Secondary School, the core subjects include Mathematics, a science subject (at the least one of Biology, Chemistry, Physics) and a vocational subject (at least one of

Agricultural Science, Electronics, Auto Mechanics, Building Construction, Applied Electricity, Home Management, Metal Work, Shorthand, Typewriting, Clothing and Textiles, Foods and Nutrition, Technical Drawing, Woodwork and Visual Art).

In most of the developing countries enrolment in tertiary institutions is lopsided in favour of art-oriented courses, at the expense of the sciences. This is due to historical antecedence. The colonial administrations emphasized this form of education (i.e., liberal arts), because they needed administrators and not technologists for smooth running of the colonies. On attainment of independence, developing nations saw the need for science, technology and mathematics education (STME). In order to rectify this lopsidedness, available literature suggests that the following be adopted as policy measures:

1. A greater porportion of educational expenditure should be devoted to science and technology, and
2. Universities and other levels of the educational system should pay greater attention to the development of scientific orientation. To this end, more colleges of Technology and Polytechnics should be opened in

a bid to improve scientific, technological and mathematical education.

- 3 The ratio of Science to Liberal Arts Students in tertiray instituions should be fixed in favour of science-based disciplines. In Nigeria, a ratio of 60:40, Science to Liberal Arts students was fixed in the Third National Development Plan (NPE, 1981 : 25). This confirms the importance the Federal Government of Nigeria attaches to science, technology and mathematics education(STME).

In spite of all the emphasis on this form of education, most developing countries suffer from the dearth of skilled professionals in basic sciences, medicine, pharmacy, agriculture, engineering and other science-oriented disciplines. The question remains : *How can Science, Technology and Mathematics Education(STME) be managed strategically ?* In order to be able to answer this question adequately, it is essential to explain what strategic management means.

### **Strategic Management**

In order to understand what strategic management means, it is essential to examine the meaning of management. Below are the three major ways of defining management:

### *Process-oriented approach*

Management is the use of resources, through team efforts to accomplish the organizational goals. It is accomplished by performing the functions of planning, organizing, staffing, directing and controlling.

### *Sociological approach*

Management refers to a class of elites that runs the affairs of an organisation. It consists of two types of classes

- a. Top Management and
- b. Operational Management

### *Field of study approach*

Management is a specialized field of study which is concerned with how organisations are administered. It consists of the following branches : Planning, Administration, Supervision and Evaluation

In view of these approaches, management is strategic. It is aimed at accomplishing certain goals. There must be some strategies or techniques to be used so as to achieve the set objectives. Strategic management therefore, is the one which is done at the top of the corporate organisation, involving the use of selected techniques, with a view to achieving the set goals or objectives. Management involves, among other things, *planning*. There are two ways top managers discharge their strategic planning responsibilities : Intuitive-anticipatory planning and formal

systematic planning. Both are important and should not be underestimated. It must be noted that managers also employ both intuitive management techniques. Strategic management and strategic planning are very vital to the success of organizations, while formal planning cannot be done without management-intuition.

Strategic management is the major task of the top management. Drucker (1974) summarized the tasks of top management as "the formulation and implementation of strategy", while on the other hand, Bower (1966) claimed that there are fourteen basic and well-known management processes which make up the components from which a management system can be fashioned. These are :

*Setting Objectives* : Deciding on the activities or programmes in which the educational system should engage and on other fundamentals that shall guide and characterize the educational enterprise such as continuous growth. An objective is typically enduring and timeless.

*Planning Strategy* : Developing concepts, ideas, and plans for achieving objectives successfully, and for meeting and beating competition. Strategic planning is part of the total planning process that includes management and operational planning.

*Establishing goals* : Deciding on achievement targets shorter in time range or narrower in scope than the objectives, but designed as specific sub-objectives making operational plans for carrying out strategy.

*Developing the institutional philosophy* : Establishing the beliefs, values, attitudes and unwritten guidelines that add up to "the way we do things around here."

*Establishing policies* : Deciding on plans of action to guide the performance of all major activities in carrying out strategy in accordance with the institutional philosophy.

*Planning the organizational structure* : Developing the plan of organisation - the "harness" that helps people pull together in performing activities in accordance with strategy, philosophy, and policies.

*Providing personnel* : Recruiting, selecting and developing people - including an adequate proportion of high-calibre talent to fill the positions provided for in the educational plan.

*Establishing procedure* : Determining and prescribing how all important and recurrent activities shall be carried out.

*Providing facilities* : Providing the plant, equipment, and other physical facilities required to carry on the educational programmes.

*Providing capital* : Making sure that adequate financial allocation is made

for the procurement of physical facilities and the running of educational establishments, i.e. running capital.

*Setting standards* : Establishing measures of performance that will best enable the educational industry to achieve its long-term objectives successfully.

*Establishing management programmes and operational plans* : Developing programmes and plans governing activities and the use of resources which (when carried out in accordance with established strategy, policies, procedures, and standards) will enable people to achieve the set goals. These are phases of the total management process that includes strategic management.

*Providing control information* : Supplying facts and figures to help people follow the strategies, policies, procedures, and programs; to keep alert to forces at work inside and outside the educational system; and to measure the performance against established plans and standards.

*Activating people* : Commanding and motivating people up and down the line to act in accordance with philosophy, policies, procedures, and standards in carrying out the plans of the company.

All these processes, without exception, are in one way or another embodied in a comprehensive formal strategic management process.

### **Strategic Management of STME**

Strategic management is basically concerned with the problem of using appropriate management techniques or tactics to achieve the set goals. What then are the set goals of STME?

In developing countries, the goals of Science, Technology and Mathematics Education ought to include the provision of :

- trained manpower in applied science, technology and commerce, particularly at sub-professional grades;
- the technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development;
- people who can apply scientific knowledge to the improvement and solution of environmental problems for the use and convenience of man;
- professional studies in engineering and other technologies;
- necessary skills leading to the production of craftsmen,

the type of education that will enable our young men and women to have intelligent understanding of the increasing complexity of technology.

In developing countries science and technology ought to be taught in an integrated manner in the schools so as to promote appreciation by students of the practical implications of basic ideas (NPE 1981:29). But field reports indicate the current situation in developing countries is far from what is anticipated. Most secondary school students are yet to have access to the practicals expected to be associated with Science, Technology and Mathematics theories. Students are bombarded with all forms of theories. There are very few ill-equipped workshops which are inadequate and not suitable for the practical lessons (Oni, 1992). A number of questions readily come to mind:

### **How is STME being managed in developing countries?**

Science, Technology and Mathematics Education is being managed through what can be termed as intuitive-anticipatory management technique in developing countries. Under this system of management, the top

management relies on intuition and anticipation for vitally all the decisions taken. Educational institutions have grown to be very complex, hence personal intuition and anticipation of managers are not sufficient for running these institutions. Education can no longer be managed through intuitive-anticipatory technique (a technique which enables one person to use his intuition and anticipation to manage an enterprise). Most educational systems have grown to a stage, in which it is no longer desirable for any Secretary or Minister of Education or State Commissioner of Education or a Local Government Supervisory Councillor for Education to apply this technique. The individual intuition cannot sufficiently take care of the increasing complexity of the education industry.

*What can be done to rectify this situation?*

The answer is obvious: **Strategic Management of Science, Technology and Mathematics**

Science, Technology and Mathematics Education can be strategically managed through the application of the fourteen processes suggested by Bower (1966), and the use of appropriate management techniques. Already, a number of management techniques are being used in the educational sector of different countries.

These include:

- Planning, Programming and Budgeting System (PPBS)
- Management-By-Objectives (MBO)
- Programme Evaluation and Review Techniques (PERT). It is also referred to as Critical Path Analysis (CPA). All these techniques have been successfully used in the industrial sector. They are also applicable in the educational sector.

The complexity of the modern day educational enterprise calls for the adoption of these cost effective and goal-oriented techniques, particularly during economic crisis. The question remains: *How do we apply these techniques to the education industry?*

Only one technique (i.e. Planning, Programming and Budgeting System (PPBS) falls within the focus of this paper, the other two can best be used at the institutional level, i.e. operational level. Management consists of (1) top management, and (2) operational management. Strategic management is the function of top management.

Management has two major units:

- (1) Planning, and
- (2) Administration.

Planning is necessary to ensure efficient allocation and utilization of scarce educational resources, while administration is to ensure organisational effectiveness. Both are necessary if the set goals are to be attained.

It is the function of top management to ensure efficient allocation, and that of the operational management to ensure optimal use of resources. PPBS can be used to ensure both. PPBS is a process by which resources are allocated to specific programmes or activities with a view to achieving desired objectives during a specific plan period.

### Conclusions

The following conclusions could be drawn from our discussion so far:

- Most developing nations recognise Science, Technology and Mathematics education as the key to economic development.
- National Policies on education ought to favour the development of STM education.

Most secondary schools in developing countries do not have workshops and laboratories needed for the teaching of the practical lessons.

- STME in developing countries is being managed through the intuitive - anticipatory technique which ought to be obsolete in a modern economy.
- Strategic management of STME is desirable in modern day economies.

### Recommendations

- In light of the global economic recession and the internal crises in most developing countries, the different levels of government should ensure the following:
- Strategic management of Science, Technology and Mathematics education, (STME) and other forms of education the key to development in all its ramifications, i.e. industrially, economically, politically, etc.. Hence STME has to be managed strategically.
- Educational expenditure should be increased, particularly, the expenditure on STME programmes. Appropriate equipment and personnel must be provided.
- There should be greater co-ordination of STME programmes. Adequate and appropriate educational resources (i.e. materials, personnel, curriculum and fund) should be provided in the different educational institutions.



- Greater attention must be given to the use and maintenance of STME material and facilities.

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