CURRICULUM RESTRUCTURING IN GEOMATICS EDUCATION: A SYSTEMS APPROACH

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ABSTRACT

Five stages of curriculum development and restructuring are identified in a systems approach. The stages are shown to be cyclic and interactive in nature and they portray curriculum restructuring process as dynamic and continuous.

The tripartite curriculum concept of "Spread", "Breadth" and "Depth' were used to obtain five modules for designing a frame work for undergraduate curriculum and four modules for postgraduate curriculum in Geomatics education. The result of user requirements survey is suggested as a vital input to curriculum restructuring so as to maintain a balance between technological innovations and the employer expectation of the product of the restructured curriculum. Some of the components of the New Geoinformation Technology and Geomatics Mapping Systems which can be incorporated into a restructured curriculum are indicated.

Since curriculum development and restructuring is a dynamic and continuous process in a systems approach, three sources of "Feed Back", from current students and graduates or products of the curriculum and employers of such graduates are regarded as crucial in obtaining a systematic, rational, and acceptable restructured curriculum in Geomatics education.
A systems approach is therefore highly recommended for curriculum development and restructuring in Geomatics education because of its obvious advantages.

1 INTRODUCTION

Digital Revolution coupled with the new Information and Communication Technology has made and will continue to make a great impact on education and training curriculums in photogrammetry, Remote sensing and GIS/LIS. This impact can be observed in the integration of these three disciplines and other aspects of surveying and mapping sciences such as Geodesy, Surveying and Cartography, with Information/Communication Technology. The adoption of an integrated approach to mapping has in turn necessitated changes in the curriculum of traditional Surveying and Mapping institutions. This impact is also observable world wide in recent times, by the changing of the names of such institutions to new names such as Geomatics, Geomatics Engineering or Geoinformatics Department to reflect restructuring of their curriculums.

In restructuring surveying and mapping curriculums such institutions are often faced with the problem of maintaining a balance between "top-down technological pressure" and the "bottom-up pressure" from users of the end products (the graduates) Krakiswsky, et al. (1992); While the former is necessary for survival, the latter is vital for the restructured curriculums to be relevant in the job market place. The objective of this paper is to discuss a conceptual curriculum-restructuring framework based on the systems approach, which strikes a balance between the technological and market place pressures.

2. CURRICULUM DEVELOPMENT AND RESTRUCTURING

2.1 Stages in Curriculum Development and Restructuring

In considering a systems approach to curriculum development and restructuring, the following five stages may be recognised, Ayeni (1992, 1997)

(i) Defining the aims and objectives and goals of the proposed curriculum programme based on technological innovation and the needs of the nation for man-power development.
(ii) Structuring of the curriculum contents of proposed educational programme identified in (i)
(iii) Defining implementation methods and strategies for the proposed contents of the curriculum.
(iv) Identifying techniques for evaluation and assessment of both the students and the programmes and finally
(v) Getting a feed back from the current students and from industry where the graduates of the new programmes are employed.

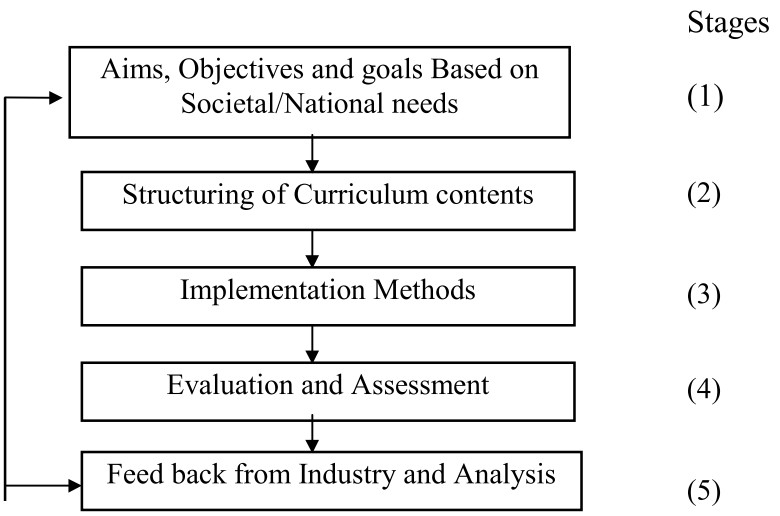


Fig. 1: Stages in Curriculum Development

The arrows in Fig. 1 depict the dynamic nature of curriculum development and restructuring . This suggests that every curriculum should therefore be revised periodically .

2.2 Cyclic and interactive nature of stages of curriculum development and Restructuring

Arising from the last stage of curriculum development process (stage 5), Fig 1., it is obvious that the feed back over the years from industry will necessitate a review of the curriculum including a revision of declared objectives and goals and curriculum contents. This will in turn affect implementation as well as evaluation and assessment methods. This shows that curriculum development is not only dynamic but also cyclic. The cyclic and the interactive features of curriculum development process are illustrated in Figs. 2 and 3, which should be used as a guidance for future refinement, restructuring and review of the curriculum. The stages depicted in Fig. 1 are not mutually exclusive. Rather they are interdependent and do interact as Fig. 3 illustrates. This implies that the modus operandi (the operational mode) for the various stages is interactive, (Nicholls et. al. (1980).

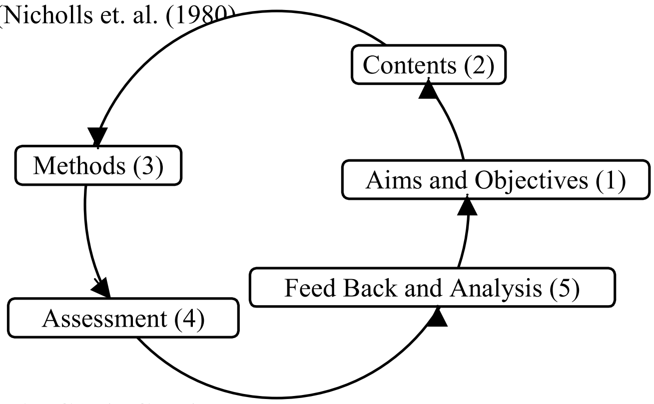


Fig. 2: Cyclic Curriculum Development Process.

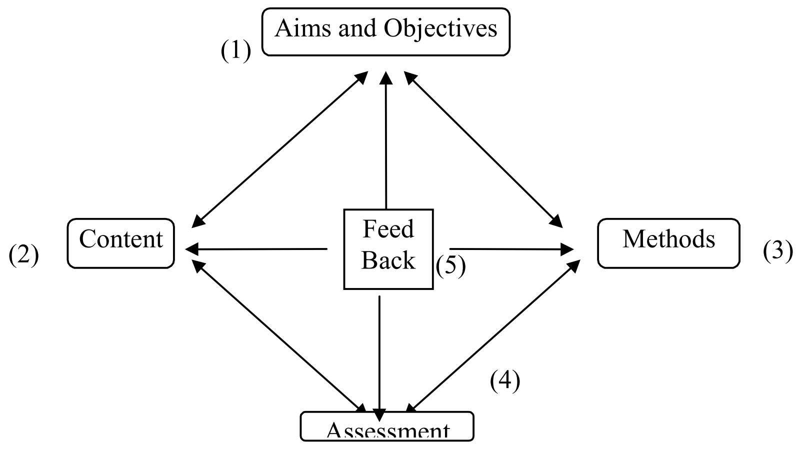


Fig. 3: Interactive Nature of Curriculum Development Process

3. AIMS AND OBJECTIVES OF RESTRUCTURING

The need for Restructuring curriculums in surveying and mapping today may be predicated on two major factors. The first is the rapid technological innovations in hardware and software and methods for carrying out mapping operations.
The second is the need to produce the necessary man-power for producing products, which will meet the needs of end users or employers. This second factor is more pronounced because of globalisation of mapping standards. Any curriculum restructure should therefore not only respond to the two factors but must maintain a good balance between them. One important aim of the restructuring is to produce man-power equipped with skills in modern techniques, which will satisfy end users in terms of high efficiency and quality and reduced cost.

Another trend in surveying and mapping is the integrated or Geomatics approach in which the various components – Remote sensing, Photogrammetry, Surveying, Geodesy Cartography and GIS/LIS – are regarded as complementary. Another objective for restructuring therefore is not to produce the traditional Surveyor's Photogrammetists, Remote sensing GIS and Cartographic experts but to produce a "resource manager" with appreciable skills in all the components for environmental development.

The digital revolution has given birth to Digital Surveying and Digital Mappping in which automation and semi-automation have become operational in the process of producing outputs such as Geodetic Coordinates in plan and height of high accuracy, digital orithophoto, digital topographic and cadastral maps. From the point of view of Professionalism and employers requirements, yet another objective may emerge, namely that a product of such restructured curriculum should be able to adopt, and assimilate new and changing technology outside his "knowledge base" in school. The expectation of the relevant professional body and the employers must be met by the graduates from such restructured curriculum. According to Krakiwsky et. al (1992), such graduates must not only be trained with a "problem solving" approach but must demonstrate capability in "problem identification".

Other localised objectives and aims of a restructured curriculum can be advanced from the rules and regulation of a professional body and government agency responsible for regulating operational activities and the practice of surveying and mapping in a country. For example such graduates may be expected to do certain courses so as to be exempted from certain examinations required for registration as a professional. Other objectives may also be identified within the larger frame work of National man-power requirements.

Ayeni (1992) has made a distinction between aims and objectives in curriculum development and restructuring. The aims of a curriculum are meant to indicate the general direction of a training or educational programme, whereas the objectives define the changes in behaviour or skills of a graduate of the programme, hence the expression "behavioral objectives".

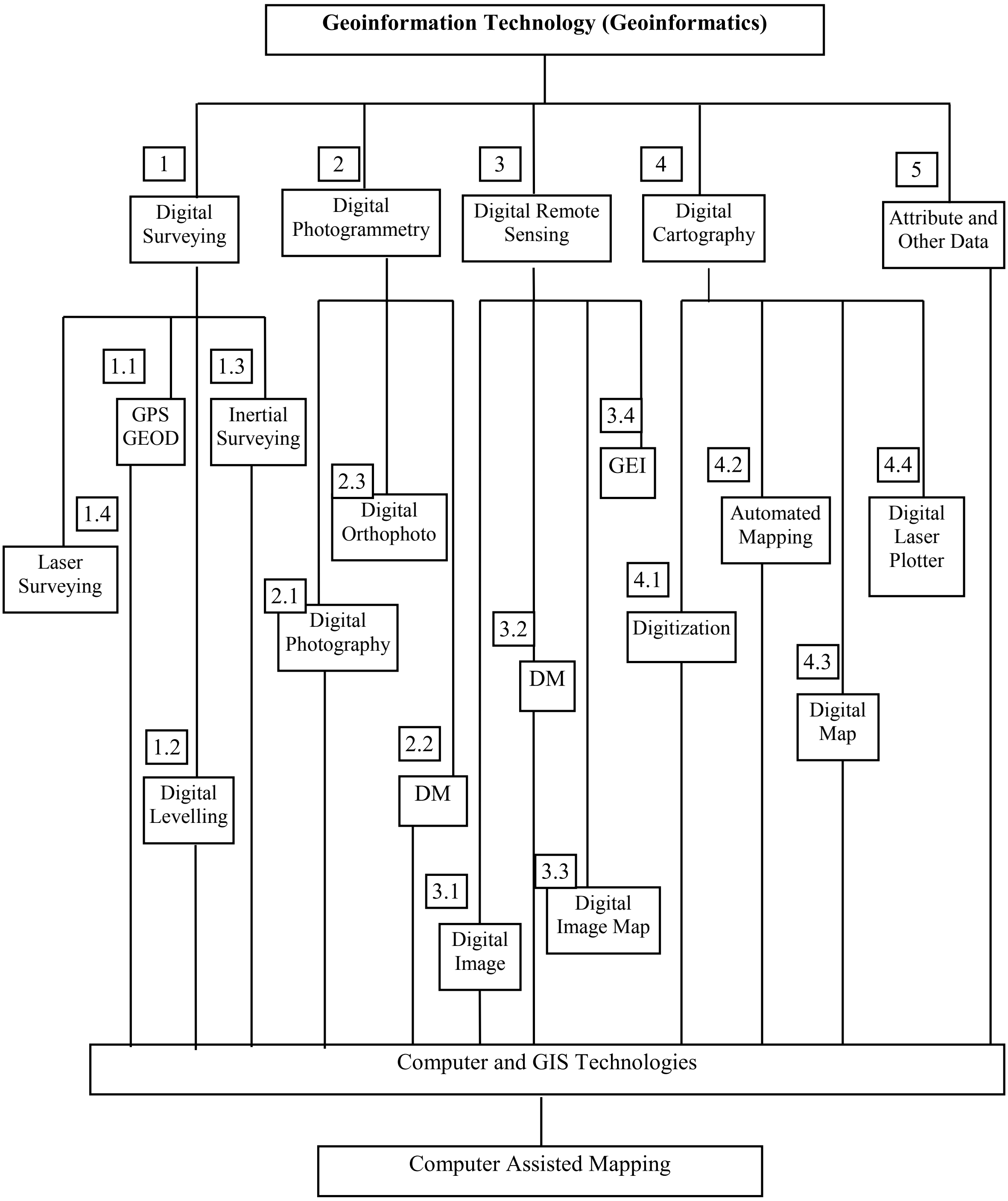
4. CURRICULUM CONTENTS FOR GEOMATICS

4.1 Factors Influencing Curriculum Contents

Several factors which are likely to influence curriculum contents may be enumerated as follows:
(i) the objectives and aims set forth for the curriculum
(ii) the state of the art of the technology at national and international level.
(iii) the professional requirements
(iv) the employer requirements
(iv) the facilities available to the training institution concerned
(vi) the human resources available for the delivery of the contents to the trainees and
(vii) the current curriculum, if any, existing in the institution
If the curriculum is not influenced by any of these factors, it is likely to be deficient. For example, the detailed syllabus for each course of the educational programme should fulfill the overall aims and objectives defined a priori for the programme.

4.2 The Technological Pressure.

The world has witnessed in the past three decades phenomenal development in science and technology as a result of Digital Revolution. Recent advancement in sensor, space and computer technologies has altered drastically many classical methods and conventional instruments in surveying and mapping. This has resulted in the New Geoinformation Technology which is constituted by components such as Digital Surveying, Digital Photogrammetry, Digital Remote Sensing, Digital Cartography and GIS/LIS, coupled with Information Technology. Fig. 4 illustrates some major components and sub-components of the New Geoinformation Technology (see Ayeni (1999) . The obvious advantages of the new technology over classical methods in surveying and mapping has imposed a great pressure on training and educational institutions to restructure their curriculums. Indeed many developing countries have been under technological pressure to change for the sake of changing. Fig. 4 indicates some of the items, which can be introduced in curriculum restructuring. The introduction of such items.



DM = Digital Mapping
GEOD = Geodesy
GEI = Geographic Imaging

Fig. 4: Geoinformation Technologies (After Ayeni (1999))

should however be done carefully after considering other factors enumerated in section 4.1 which should influence curriculum contents.

4.2.1 Geomatics Approach.

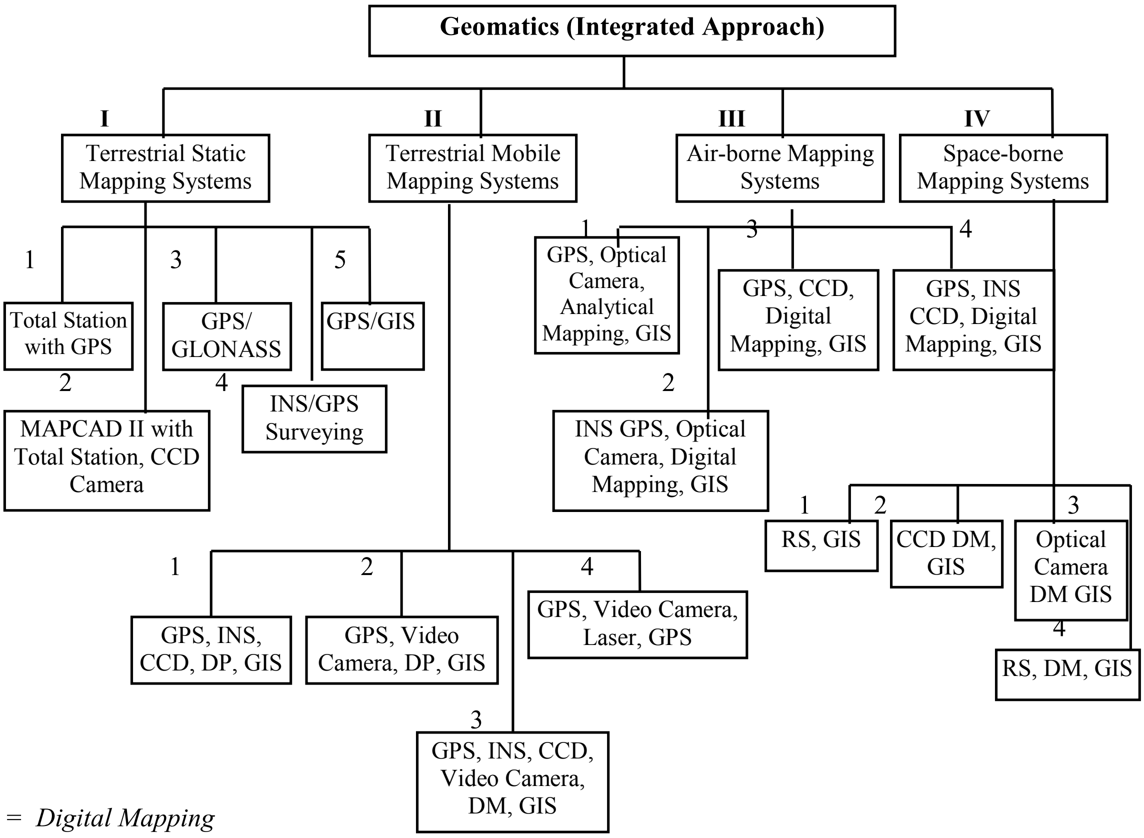
Geomatics approach for the purpose of this paper simply means integrated approach to surveying and mapping. The individual components in Fig. 4 according to this approach are complementary in creating a resource or environmental spatial data base of which one of the outputs is a map in hardcopy or digital format. Fig. 5 depicts four examples of Geomatics systems which can generate Geospatial Data Base for GIS.

(i) Terrestrial Static Mapping Systems is constituted by a combinations of any of the emerging technologies such as, Total Station, GIS, GLONASS, INS, CCD camera, video camera and GIS, and the appropriate soft ware to produce the spatial Database

(ii) Terrestrial Mobile mapping systems represent any combinations of new technologies carried on board a ground mobile vehicle to achieve the same result as in (i). after computer and photogrammetric processing.

(iii) Air-Borne Mapping Systems are data acquisition systems such as GPS, receivers, INS, video camera and CCD or optical camera, carried on board an Aircraft and Analytical/Digital Photogrammetry is used with the computer hardware and software to achieve the same purpose in (i).

(iv) Space-Borne Mapping systems make use of artificial satellites as carriers for data acquisition systems suitable for processing by Digital Remote sensing or Digital Photogrammetry to achieve the same result as (i) (see Ayeni 1999 for details).



DM = Digital Mapping
RS = Remote Sensing

Fig. 5: Geomatics: Integrated Approach to Geoinformation (After Ayeni (1999))

4.3 Users Requirements Survey

If curriculum development or restructuring were to depend on technological pressure alone all the technologies shown in Figs. 4 and 5 could as well be incorporated into the new curriculum. However the product of such a new structure may not be suitable for the market place (Labour market). User requirements survey is therefore very vital before undertaking curriculum restructuring. Users input to curriculum can be obtained through a well-designed questionnaire survey of actual and potential employers. Questions should include the following; which of the classical methods are still relevant? “which of the emerging technologies are most relevant and should be incorporated?, “what should be the behavioral objectives of the restructured curriculum?" A statistical analysis of the results of such survey will indicate the type of balance which should be maintained between technological innovations and users requirements.

4.4 Tripartite Concept of Curriculum Structure.

How should a curriculum be structured in the light of the innovative technologies which have permeated surveying and mapping? Ayeni (1997) has proposed a tripartite concept for curriculum structures – According to this concept a curriculum should have a " Spread", "Breadth" and "Depth". "Spread" ensures a broad-based education in other ostensibly un-related disciplines; "Breadth" assures that knowledge in cognate disciplines in Fig. 4 is acquired. "Depth" guarantees that the curriculum produces competence in two or three of the components illustrated in Fig. 4 or Fig. 5.

4.4.1 Undergraduate Curriculum Structure

The curriculum structure for undergraduates can be divided into five modules as shown in Table 1. Modules I and II represent the "Spread", Module III depicts the "Breadth" and Modules IV and V describe the "Depth". Model I consists of general courses not necessarily related to Geomatics but which broadens the students education. Module II consists of courses which provide the students with mathematical, statistical and computer skills necessary to understand modules III-V. Module III can be regarded as consisting of introductory courses in as many components of Geoinformation Technology in Figs 4. Module IV is the specialisation in at least two or more related components in Fig. 4. The practical work including final year Project Constitutes Module V. How much of the old syllabus should be retained and how much of the new components of Geoinformatics should be added will depend on the result of user requirements survey.

MODULE	CURRICULUM CONTENTS	TRIPARTITE CONCEPT
Module I	General Courses	
Module II	Mathematical foundation courses	Spread
Module III	Pseudo-Specialised Courses	Breadth
Module IV	Specialised Courses	
Module V	Specialised Practical Project	Depth

Table 1: Tripartite Concept for Curriculum Structuring (After Ayeni (1997))

4.4.2 Post graduate Curriculum Structure

For postgraduate programme, the tripartite concept still holds, but the relevant modules are modules II-V. With more emphasis on the "depth" concept for the purpose of research. The area of "Depth" in modules IV and V will therefore be narrower and deeper than the undergraduate programme; consequently the amount of time devoted to "Depth" will be greater than that of the undergraduate programme. A postgraduate programme will also pay more attention to research in Geomatics systems in Fig. 5.

5 EVALUATION FEED BACK AND ANALYSIS

Any new or restructured curriculum must be evaluated and assessed frequently so as to maintain the dynamic nature of curriculum development. The result of the evaluation constitutes a vital input into any future curriculum revision or restructuring.

5.1 Evaluation and assessment of student performance

This is usually done by way of Quiz, test, examination, term paper, project, seminar, Practical Task, thesis and dissertation, Ayeni (1992, 1997) There are three types of assessment – terminal, periodic and continuous assessment. The results of the evaluation and assessment over a period of three to four years must be analysed and studied to see if the curriculum contents and the instructional methods and facilities need to change. The is first the "Feed Back from students.

5.2 Course Evaluation

This exercise is meant to allow students evaluate a curriculum as well as the facilities available and the teachers ability and capability. This is usually done by students who are requested to complete anonymously a questionnaire at the end of the course. The questionnaire must be carefully done to highlight some important features of the course. The diagnosis and analysis of the findings of the completed questionnaire represent the second “Feed Back” which must be ploughed back into future revision of the curriculum.

5.3 Evaluation of Graduate’s Performance

This evaluation is made in the industry where the products (graduates) of the curriculum are employed. This is the third “Feed Back”. The questionnaire survey to be used must be carefully designed and completed by both the graduates produced from the curriculum and by the employers. From the analysis of responses to the questionnaire, the aims and objectives, the adequacy of curriculum contents and instructional methods can be re-evaluated. The three types of “Feed Back” described in this section will make curriculum restructuring easy, systematic and rational.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

In a systems approach five stages in curriculum development and restructuring have been identified as depicted in Fig. 1. It has also been demonstrated that curriculum development and restructuring is a dynamic as well as a continuous process (see Figs. 1 and 2). The interactive and cyclic nature of the various stages in curriculum development is illustrated in Figs. 2 and 3.

The tripartite concept of “Spread”, “Breadth” and “Depth” was unutilised to obtain five modules for designing a frame work for undergraduate curriculum (modules I –V) and modules (II –V) for postgraduates (see Table 1). Fig. 4 indicates the components of the New Geoinformation Technology and Fig. 5 shows four Geomatics systems for mapping and for GIS which can be incorporated into a restructured curriculum in Geomatics education.

Since curriculum restructuring is a continuous process, the three sources of “Feed Back” discussed in section 5 should be explored so as to make curriculum restructuring, a rational and acceptable balance between technological pressure and users requirements.

6.2 Recommendation

A systems approach is highly recommended for curriculum development and restructuring because of its obvious advantages such as:

(i) the stages of curriculum development are clearly defined as cyclic and interactive

(ii) curriculum development and restructuring is presented as a dynamic and continuous process.

(iii) the sources of “Feed Back” are identified, -students, graduates and industry – which will make future re-structuring a systematic, rational and acceptable balance between technological innovations and users requirements.

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CURRICULUM RESTRUCTURING IN GEOMATICS EDUCATION: A SYSTEMS APPROACH Olubodun AYENI. University of Lagos, Lagos Nigeria Faculty of Engineering. Department of Surveying and Geoinformatics eayeni@oauife. edu.ng.Â Since curriculum development and restructuring is a dynamic and continuous process in a systems approach, three sources of â€œFeed Backâ€, from current students and graduates or products of the curriculum and employers of such graduates are regarded as crucial in obtaining a systematic, rational, and acceptable restructured curriculum in Geomatics education. A systems approach is therefore highly recommended for curriculum development and restructuring in Geomatics education because of its obvious advantages. A science education system must be responsive to a variety of influencesâ€"some that emanate from the top down, some from the bottom up, and some laterally from outside formal channels. spent on science.Â Curriculum refers to the knowledge and practices in subject matter areas that teachers teach and that students are supposed to learn.Â Others have investigated curricular approaches and instructional practices that are matched to national standards [52] or are focused on model-based inquiry [24]. In some work, there is a particular interest in the role of studentsâ€™ learning of scientific discourses, especially argumentation [33, 53, 54]. Taken together, this work suggests teachers need to develop the capacity to use a variety of approaches in science education. Semantic Scholar extracted view of "A systems approach to restructuring a health care curriculum." by J. Lanier et al.Â @article{Lanier1979ASA, title={A systems approach to restructuring a health care curriculum.}, author={J. Lanier and R. L. Brown}, journal={Program notes}, year={1979}, volume={82}, pages={. 19-23 } }. J. Lanier, R. L. Brown. Published 1979. Medicine. Program notes. View on PubMed. Educational Technology as a systems approach: All attempts made to define the concept of educational technology as an area of study involving the application of technologies emerged from the application of theories of learning and development as well as information and communication technologies have not been comprehensive enough without a theoretical grounding in the social context. The use of these technologies has to be grounded in a theoretical foundation provided by a systems perspective. The Curriculum Title: Diploma in Geomatics Engineering. Aim The program aims to produce middle level technical personnel with sound academic knowledge equipped with perfect technical skills that can be faced in real life situation. Program Objectives After the completion of this program, the graduates will be enabled toÂ Teaching Learning Methodologies The methods of teachings for this curricular program will be a combination of several approaches such as; illustrated lecture, tutorial, group discussion, demonstration, simulation, guided practice, fieldwork, block study, industrial practice, report writing, term paper presentation, heuristic and other independent learning exercises.