The International Journal Of Engineering And Science (IJES)
||Volume||2 ||Issue|| 11||Pages|| 77-81||2013||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

The Role of Computer Technology in Mechanical Engineering Education in Kenyan Universities

Ogur, E. O[1]. and Ogola, W. O[1].
[1,2],*Department of Mechanical & Mechatronic Engineering, Kenya Polytechnic University College, P.O. Box 52428 – 00200, Nairobi*

----------ABSTRACT----------
This paper examines the extent of exposure of mechanical engineering students in two Kenyan universities and colleges of technology to engineering computer application programmes. In view of this, a survey study was adopted, two research questions were raised and a null hypothesis formulated. The population of the study consisted of 225 final year engineering students from two leading Kenyan universities of technology that offer mechanical engineering education programme. The findings of the study indicate a relationship between engineering computer application programmes and engineering education programmes in Kenyan universities. The study also reveals a significant difference between the exposure of engineering students to engineering computer application programmes and the expected exposure in Kenyan universities. To address these deficiencies revealed by the study, the researcher recommended among others the expansion of the curriculum of engineering education programmes to include courses like introduction to Computer Aided Design using 3-D modelling software, introduction to programming languages like Matlab or MathCAD and introduction to finite element modelling packages for numerically solving a wide variety of mechanical engineering problems.

KEYWORDS: *Computer aided design, programming, finite element modelling*

Date of Submission: 28 March 2013 Date of Acceptance: 20 November 2013

I. INTRODUCTION

Recent developments in Mechanical Engineering have been paralleled by the development of the computer as an important adjunct to the modern engineer. The relationship between Mechanical Engineering practice and computational problem solving techniques already has been considerable, but the full impact of computers on Mechanical Engineering education is very vast. The rapidly enlarging capabilities of computers have already enlarged the scope of practical and theoretical problems which confront the Mechanical Engineer. These capabilities constitute the computer technology with which graduating Mechanical Engineers must be familiar. What impact does the computer have on the educational process? The effectiveness of engineering teaching is in part related to the understanding and utilization of principles of learning by the teaching staff. Curriculum planners must therefore give serious consideration to what, how much, and where instruction in computational problem solving techniques is to fit into the Mechanical Engineering curriculum [1].

1.1 Statement of Problem

Interactions with the graduates of mechanical engineering education from Kenyan universities and colleges that offer mechanical engineering programmes reveal that the graduates of mechanical engineering in this era of advanced computer software technologies are missing out on opportunities to develop soft skills that will enable them to design and simulate manufacturing processes and operations. This is as a result of their inadequate exposure to the practical application and use of advanced computer aided engineering technologies such as computer simulation analysis packages.

1.2 Objectives of the study

The objectives of the study are to:
(i) determine the relevance of computer aided engineering application packages (Matlab, MathCAD, ANSYS, COMSOL Multiphysics, Moldflow and SolidWorks) for the mechanical engineering education programme in Kenyan universities and colleges.
(ii) determine the extent to which university mechanical engineering students are exposed to practical application of Matlab, MathCAD, ANSYS, COMSOL Multiphysics, Moldflow and SolidWorks.

1.3 Research Questions

Based on the above stated specific objectives of the study, the following research questions were raised:-

(i) How relevant are computer application packages such as Matlab, MathCAD, ANSYS, COMSOL Multiphysics, Moldflow and SolidWorks to mechanical engineering students in Kenyan universities and colleges.

(ii) To what extent are the engineering students in Kenyan universities exposed to Matlab, MathCAD, ANSYS, COMSOL Multiphysics, Moldflow and SolidWorks?

Null Hypothesis:

- There is no significant relationship between mechanical engineering education programme in Kenyan universities/ colleges and computer aided engineering problem solving techniques.

1.4 Significance of the Study

The findings of this study would be significant to curriculum designers to expand the curriculum of mechanical engineering education programme in Kenyan universities and colleges to include the study of computer aided engineering packages and other related simulation analysis software that are relevant to mechanical engineering students. The mechanical engineering students too would be adequately exposed to the practical applications of advanced engineering software for numerically solving a wide variety of mechanical engineering problems It is understood that this early exposure to computers affords the student a structure for building their own perception and gaining useful experience in determining those areas in which computers may have immediate application [2].

II. RESEARCH METHODOLOGY

The study was conducted using the following research methods:

2.1 Research Design.

The survey research design was adapted for this study since the study required the use of a questionnaire to collect data from the sampled population.

2.1.1 Population for the Study

The population for the study was 225. This consisted of 225 final year engineering students from the department of Mechanical engineering. The choice of final year engineering students was based on the researcher's assumption that the graduating students were expected to have adequate exposure to computer aided engineering problem solving techniques.

2.1.2 Sample Size and Sampling Procedure

The sample size of the respondents for questionnaire distribution is computed using the formula as follows [3]:

$$n = \frac{N}{1 + N(e)^2}$$

Where: N = Study population
e = Marginal error
n = Sample size

Now, computing the sample size at 95% confidence level (i.e. e = 0.05), we have:

$$n = \frac{225}{1 + 225(0.05^2)}$$

$$n = 144$$

Therefore, 144 questionnaires were administered.

III. RESULTS AND DISCUSSIONS

The number of the questionnaires completed and returned by our respondents totalled 144, which represents 100% of the total number of questionnaires administered. The questions and responses on them are presented in the table 1 below:

Table 1: Contingency Table of the Responses of our Respondents

Questions	Responses					Total
	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)	
Q1. How relevant are computer programming and engineering computational methods?	132	12				144
Q2. How irrelevant are computer programming and engineering computational methods?	21	3	18	72	30	144
Q3. Are computer programming and engineering computational methods relevant for teaching of mechanical engineering education in university?	123	18			3	144
Q4. Are computer programming and engineering computational methods taught in your university/college?	27	108	9			144
Q5. Are MathCAD, Matlab, AutoCAD, ANSYS, COMSOL Multiphysics taught in your university?	18	117	3	3	3	144
Q6. Are Finite Element Modelling and Computational Fluid Dynamics courses taught in your university?	6	12	27	84	15	144
Q7. Do you have access to computers for practical training in your university/college?	15	117	9	3		144
Q8. Have at least 3 credit hours been allocated in your university/college for computer programming and engineering computational methods?	21	111	12			144
Q9. Do you possess the ability to use computers to solve engineering problems?	24	54	63	3		144
Total	387	552	141	165	51	1296

After testing the hypothesis using Chi-Square (χ^2), the value obtained for the calculated value of χ_{Calc}^2 is 1632.0742, while the critical value at 5% significance level and a degree of freedom of 32 gives the value of $\chi_{0.95}^2$ as 46.2. Since the calculated value of χ_{Calc}^2 is greater than the critical value of $\chi_{0.95}^2$, the study therefore rejects the null hypothesis that there is no significant relationship between mechanical engineering education programme in Kenyan universities/ colleges and computer aided engineering problem solving techniques.

IV. RESEARCH QUESTION ONE

How relevant are the computer application packages like Matlab, MathCAD, ANSYS, COMSOL Multiphysics, Moldflow and SolidWorks to mechanical engineering students in Kenyan universities?Questionnaire item 1 dealt with the relevance of computer programming and engineering computational methods in mechanical engineering education programme in Kenyan universities. On the whole, 144 respondents, representing 100% of the total respondents to item 1, affirmed that computer programming and engineering computational methods are very relevant. Questionnaire item 2 sought to find whether computer programming and engineering computational methods are not relevant to mechanical engineering education programme in Kenyan universities. Total agree for questionnaire item 2 representing 16.67% against total disagree representing 70.83%. The undecided represented 12.5%. Questionnaire item 3 sought to know whether computer programming and engineering computational methods relevant for teaching of mechanical engineering education in university. Total agree representing 97.92%, against total disagree, representing 2.08%. This implies that computer programming and engineering computational methods are relevant to mechanical engineering education.

Questionnaire item 4 sought to know whether computer programming and engineering computational methods are taught in the university/college. Total agree stood at 135, representing 93.75%, against 9 for the undecided representing 6.75%. This implies that computer programming and engineering computational methods is relevant to mechanical engineering education.

V. RESEARCH QUESTION TWO

To what extent are the engineering students in Kenyan universities exposed to Matlab, MathCAD, ANSYS, COMSOL Multiphysics, Moldflow and SolidWorks? Questionnaire item 5 sought to know whether MathCAD, Matlab, AutoCAD, ANSYS, COMSOL Multiphysics taught in the university/college. On the whole, total agree scored 135, representing 93.75%, while total disagree scored 6 representing 4.17%. The undecided represented 2.08%. This implies that the majority of mechanical engineering students in Kenyan universities know about advanced computational software. It is observed in this item that knowing about the programs' existence does not mean that the students use these programs for their education and development [4].Questionnaire item 6 stated that "are Finite Element Modelling and Computational Fluid Dynamics courses taught in your university". On the whole, total agree scored 18, representing 12.5%, while total disagree scored 99, representing 68.75% with the undecided representing 18.75%. This implies that mechanical engineering students in Kenyan universities are not taught Finite Element Modelling and Computational Fluid Dynamics.
Questionnaire item 7 dealt with the issue of students having access to computers for practical training in the university/college. On the whole, total agree scored 132, representing 91.67%, while total disagree scored 9, representing 6.75% with the undecided representing 2.08%. Questionnaire item 8 was on whether students had at least 3 credit hours allocated in the university/college for computer programming and engineering computational methods. The total score for agree stood at 132, representing 91.67%, while the total score for disagree stood at 8.83%. This implies that most of the mechanical engineering students have access to the computers in the department for practical work.Questionnaire item 9 sought to find out whether students possessed the ability to use computers to solve engineering problems. The total sore for agree stood at 78, representing 54.17%, while the total score for disagree was 3, representing 2.08%. The undecided made up 43.75% of the total. This implies that there are almost as many student with knowledge of computational problem solving skills as are those who do not have the knowledge. More effort is required in this regard.

VI. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, the following conclusions are drawn:

- Computer aided engineering software application packages like Matlab, MathCAD, ANSYS, COMSOL Multiphysics, Moldflow and SolidWorks are relevant to mechanical engineering education programme in Kenyan universities and colleges
- There was significant difference between the exposure and application of mechanical engineering students to computer aided engineering software application packages and the expected exposure of mechanical engineering students in Kenyan universities. 68.75% of the students were not adequately exposed to the practical application of computer application packages such as Matlab, MathCAD, ANSYS, COMSOL Multiphysics, Moldflow and SolidWorks®. The consequence of this is that the university mechanical engineering graduates do not possess the ability to use computers to solve engineering problems.

To address the problem of non-exposure of mechanical engineering students to computer aided engineering software and application packages, it is recommended that the Curriculum Experts should expand the curriculum of mechanical engineering education programme in Kenyan universities and colleges to include the following suggested courses:-

Introduction to Finite Element Modelling using CAE software

Students should be introduced to the fundamentals of finite element modelling using software like ANSYS and SolidWorks®. This will enable them gain a working knowledge of computer modelling, design and problem solving of complex challenges which are beyond the analytical theories taught. Two lecture hours per week and two hours of laboratory per week is suggested for this course.

Introduction to 3-D Computer Aided Design using SolidWorks®.

Students should be introduced to 3–D computer aided design to allow students to develop soft skills that will enable them to design parts, assemblies and drawings on the computer. This will greatly improve their product design skills allowing them to make as much iteration as necessary in order to get their design right first time. Two lecture hours and two laboratory hours per week are suggested for this course.

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