INNOVATIVE DEVELOPMENT OF MATERIALS FOR ECONOMIC DIVERSIFICATION: *MATERIALS SCIENCE AND ENGINEERING EDUCATION.*

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Abstract

The phrase "Materials is everything and everything is materials", is no less true for either the Materials engineer, the Industrial Microbiologist, the Petroleum/Chemical engineer or the Mechanical engineer. It tends to take on a deeper meaning when considered from the perspective of materials as a constituent of the physical universe and a necessity in engineering practice or education. The research work builds upon the latter, considering the numbers of institutions of higher learning (Universities) that accords the study of both Materials Science and Engineering its proper significance in the innovative development of materials to aid the economic diversification of the Nation. Using Comparative Analysis as Methodology, a premium statistical analytic software known as SPSS is utilized in the analysis of the research data. The research findings shows that of the approximately one hundred and fourteen (114) accredited universities offering engineering based education, only eleven-point-four percent (11.4%) offers material science and engineering as a specialized form of engineering education. This implies that the usage of innovatively developed materials as a means for economic diversification is truncated mainly due to, the unavailability of the necessary engineering education based knowledge. The research work proffers some obvious and

unorthodoxly viable solutions that is geared towards national greatness through materials science and engineering.

Keywords: *SPSS, Comparative Analysis, Economic Diversification, Industrial Microbiology, Petrochemical.*

INTRODUCTION

Science and technological innovations is inconceivable without materials science. For, upon what would engineers ply their trade without materials science? Of what value is science and engineering education without the study of the innovative production, types, processes and uses of materials that are products of a logically systematic and scientific investigations of the
'Materials' found in and within the physical universe? No nation can or will attain any tangible progress in the sphere of science and technology without a thoughtful consideration and investment of 'Men, Materials and Machines' to the probing of nature, in order to unlock her hidden treasures in the varied plethora of different forms, nature and types of 'Materials'. Since education is the bedrock of a Nation, the need to make the study of materials science an important factor in engineering education can never be overemphasized, since its effect can be seen in cultural, economic and social wellbeing of the society.
This research work takes a comparative look at the relative importance allocated to the investigation of materials science as a necessary component in engineering education. Using the tertiary institution (Universities) in Nigeria as a case study, comparison is made in the numbers of educational institutions dedicated to the unlocking of nature's puzzling order and disorder in the creation of varied engineering materials and the innovative utilizations of this knowledge in the production of more complex artificial materials. The result of the finding is then used to make suggestive statements on the implications on the overall technological advancement and wellbeing of the Nation. Before any evaluation and/or contemplation of the empirical data use for analysis is given further thought, it is of necessity to give a concise meaning and discussion to 'Material Science as "Science"', 'Material Science and Engineering Education' and "Multidisciplinary nature of Materials Science" as detailed below

1a. ***Materials Science, as "Science":*** the study of "Materials" is as old as human civilization. From time immemorial, man had sought ways of making and improving upon that which he finds in and without his physical reality. The answer to the question "What is 'Materials Science', "Scientifically Speaking"?, would be relatively dependent on who is asked. For some, it is the mythological "Pandora's Box", that holds the key to unlocking the 'Chaos' of empty space. For others, especially William & David (2010), it is primarily concerned with the investigation of the inherent relationship existing between the "Structures" and "Properties" of matter. To stay within the research limitations, Materials Science, scientifically speaking, is considered to be the study of the "Microscopic and Macroscopic" nature of any and every kind of substance along with the behaviour (Properties) of that substance when it interacts with external stimuli. The advantage of this perspective of reasoning, is that it allows the research to utilize the traditionally conceptual "Materials Science Octahedron" view (See Figure 1),
allowing for the obvious multidisciplinary nature of materials science.

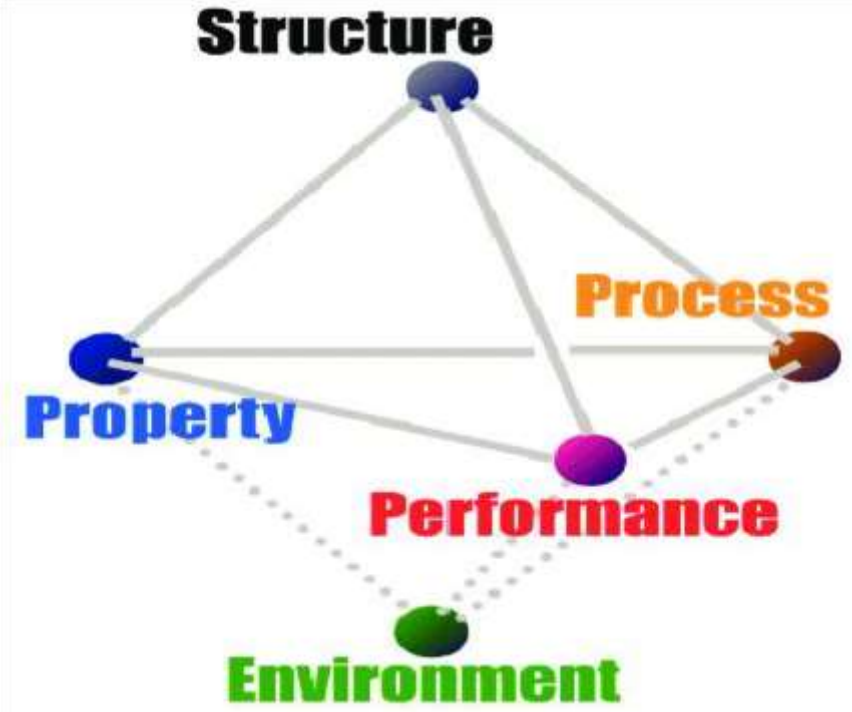

Figure 1. Conceptual Materials Science Octahedron

1b. ***Material Science and Engineering Education:*** the true essence of a higher institution of learning, is the education of its students, in a conducive

environment that encourages open exchange and the dissemination of ideologies and knowledge, as posited by Annual Review of Materials Science (2020). If the education is engineering based, it would be incomplete without the knowledge of materials science. This is because, the understanding of the principle upon which any and every engineering material operate and achieve optimum performance, is highly dependent on knowing both its microscopic and macroscopic properties and this knowledge depends on materials science. For developing nations like Nigeria, whose road-map to greatness must include innovative development of indigenous materials, to aid economic diversifications, the need to make materials science an integral part of its engineering education cannot be over-emphasise. It is against this backdrop, that the research was conducted, to evaluate and re-emphasise the need to make materials science a significant part of both its science and engineering education, as is done in developed nations. (See Figure 2)(See Figure3)

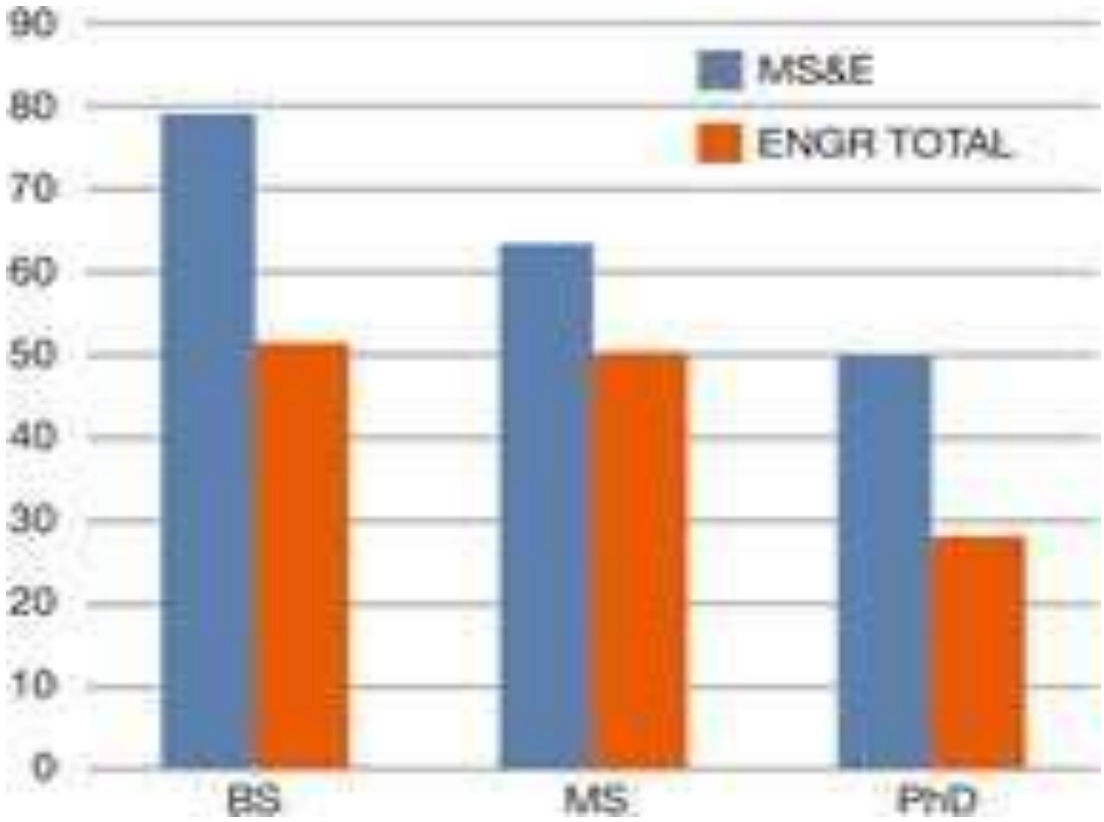

Figure 2. Percentage Enrolment in Material Science and Engineering Education in America Universities

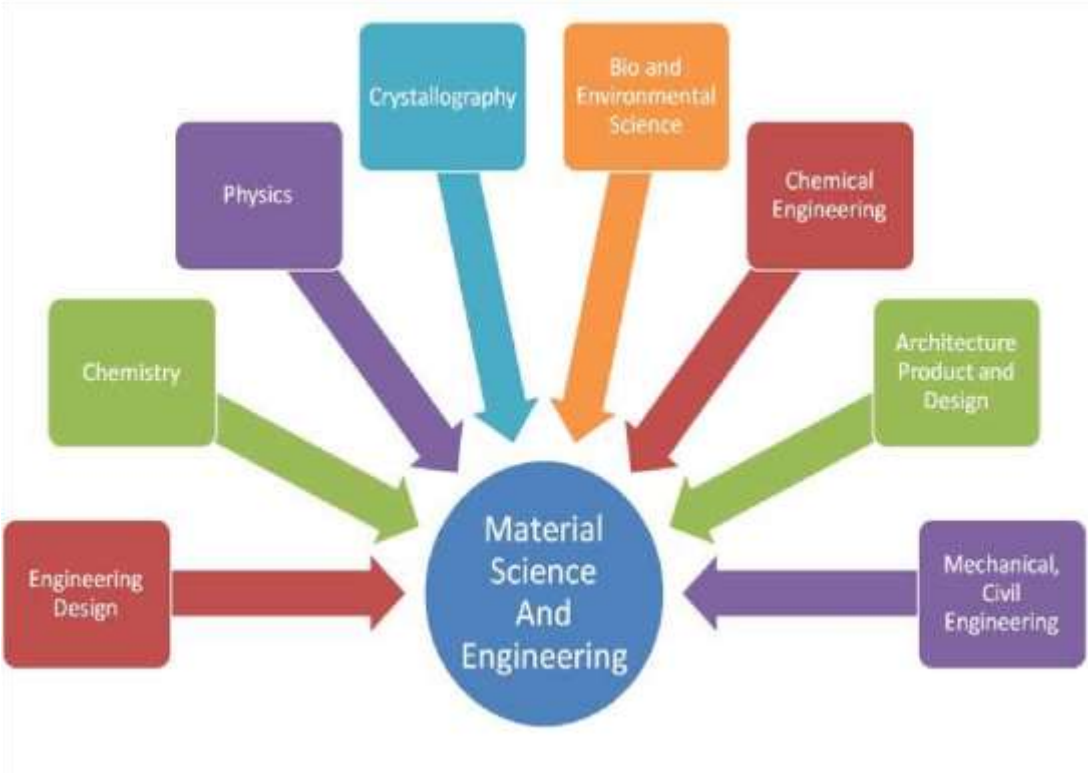

Figure 3. Materials Science and Engineering Education

1c. ***Multidisciplinary nature of Materials Science:*** due to the inexhaustible nature of the connectivity between material science and every other engineering and non-engineering profession and to limit the scope of the research, the inter-relationship between materials science and three core professions dedicated to science, technology and innovation, is considered, as detailed below:

1c1. ***Materials science and Mechanical Engineering****:* using the traditional conceptual "Materials Science Octahedron" (See Figure 1) as a visual aid, the inter-connectivity of material science and other branches of the engineering profession becomes obvious. For John.A.Paulson of the Harvard School of Engineering, the relationship between materials science and mechanical engineering is noted in the characteristic "Performance" of a mechanical system through the knowledge of the mechanics of dislocations and other imperfections, grain boundaries, interfaces and material heterogeneity (John, 2018). This

"Characteristic of Performance" can only be known through the study of the "Materials" of the mechanical system. (See Figure 4)

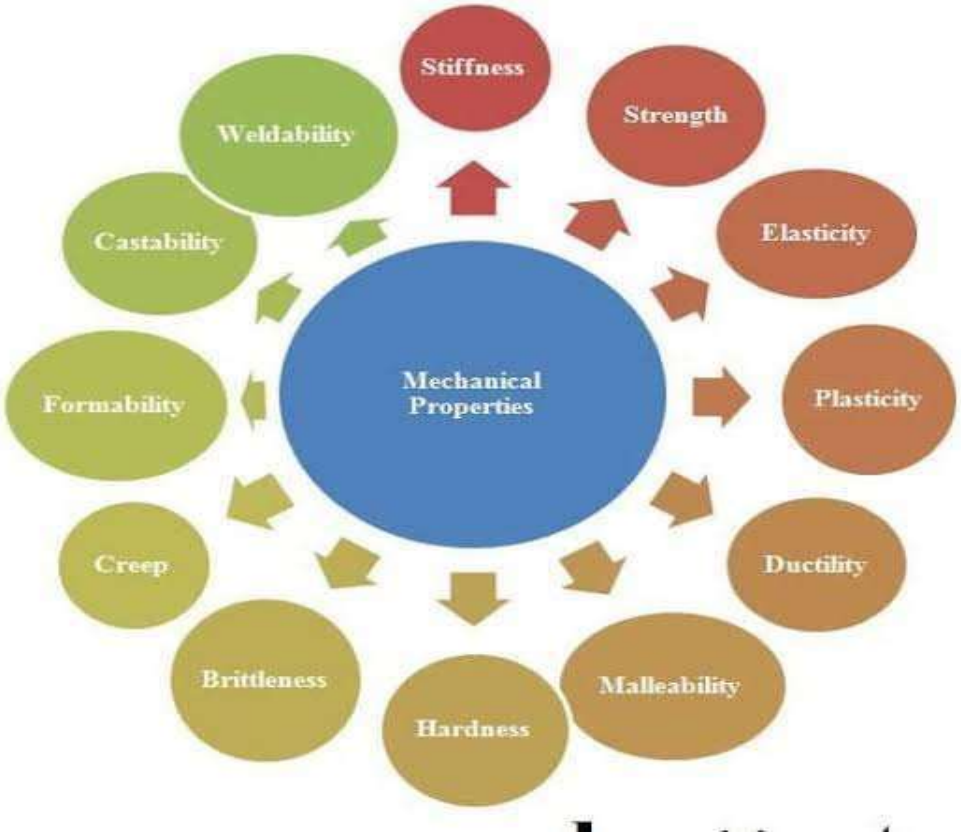

Figure 4. Characteristic of Performance of a Mechanical system that require knowledge of Material Science

1c2. ***Materials science and Industrial Microbiology:*** industrial microbiology is a multidisciplinary science, which along with molecular biology, biochemistry, biotechnology, among others, utilises "Materials", organic and otherwise, for the discovery, development or/and implementation of certain processes and quality of resultant products like *antibiotics, vaccines, health-care products, food/beverages produced by microbial activities, enzymes, organic chemical, contamination control,* etcetera (Society for Industrial Microbiology and Biotechnology [SIMB], 2020). The societal importance of industrial microbiology and the resultant bi-products/ materials manufactured is highlighted in the figure below.

Figure 5. Resultant "Materials"/ Products of Industrial Microbiology

1c3. **Materials Science and Chemical/Petro-Chemical Engineering**: chemical engineers and their allied professions, Petro-chemical engineering, had over the years, using knowledge acquired through material science, characterise and then modified molecular structures of the materials within their field, in order to enhance desirable physical properties and performance attributes, while suppressing unwanted ones. The ability to create these advanced materials with superior properties that allow for successive performance under increasing punishing operating conditions, are an attributes to the inter-disciplinary nature of materials science (America Institute of Chemical Engineers[AIChE], 2017).

Figure 6. By Products of the inter-disciplinary nature of Chemical/Petroleum

Engineering and Materials Science

Having explored the inter-disciplinary or multi-disciplinary nature of *Material Science*, a case study is made from institutions of higher learning in Nigeria. A statistical analysis is made to ascertain the level of priority given to this branch of knowledge that is essential to the innovative development of materials for economic diversification and technological advancement of the Nation.

MATERIALS & METHOD

The data set of information used for computational analysis, is gathered from, Nigeria

University Commission (NUC), Websites of NUC accredited universities, Joint Admission and Matriculation Board (JAMB), Wikipedia and several other reliable information sources, as referenced. Using Comparative Analysis as Methodology, a premium statistical analytic software known as SPSS (Statistical Program for Social Science) is utilized in the analysis of the acquired research data. The essence of utilizing the statistical program, is to limit or

eliminate computational error, while providing info-graphical information that clearly summarizes the research findings.

RESULT AND DISCUSION

1. RESULT

In the analysis of the data set for the research work using SPSS (Statistical Program for the
Social Science), six (6) variables was created, which are: *Institution, Year of Establishment, Ownership of Institution, Faculty of Engineering, Department of material science,* and the academic *Level* at which materials science and engineering is studied. Values where assigned to four (4) of the six (6) variable, as shown below. (See Table 1)

Ownership of Institution	*Faculty of Engineering*	*Department of MS&E*	*Level*
1= Privately Owned	0=No Faculty of Engineering	0=No Dept of MS&E	0=MS&E not Offered
2=State Owned	1=Faculty of Engineering Available	1= Dept of MS&E Available	1=MS&E Offered in First Degree
3=Federal Owned			2=MS&E Offered in Second Degree
			3=MS&E Offered in Third Degree
			4=MS&E Offered at all Level

Table 1. Assigned Values to SPSS Variables, where MS&E means Materials Science and Engineering

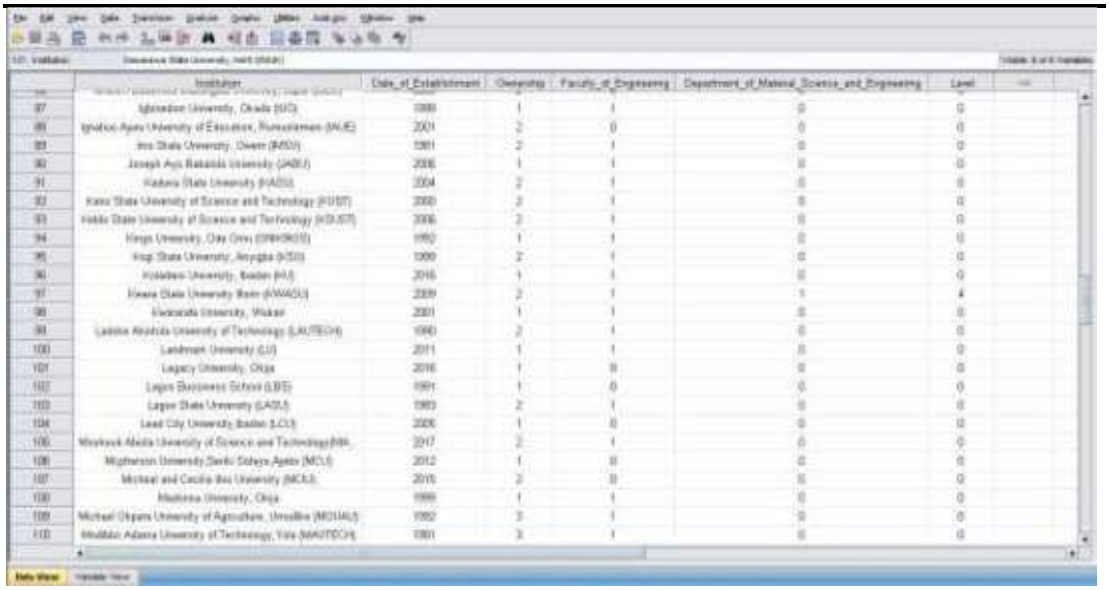

Figure 7. Screen shot of the collated data in SPSS

Frequency Table

Ownership of Institution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		2	1.1	1.1	1.1
	Privately Owned	78	44.6	44.6	45.7
	State Government Owned	50	28.6	28.6	74.3
	Federal Government Owned	45	25.7	25.7	100.0
	Total	175	100.0	100.0	

Faculty of Engineering

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Factulty of Engineering	59	33.7	34.1	34.1
	There is a Faculty of Engineering	114	65.1	65.9	100.0
	Total	173	98.9	100.0	
Missing	System	2	1.1		
Total		175	100.0		

Department of Materials Science

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	There is no Department of Materials Science	161	92.0	93.1	93.1
	There is a Department of Materials Science	12	6.9	6.9	100.0
	Total	173	98.9	100.0	
Missing	System	2	1.1		
Total		175	100.0		

Accademic Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not offered at any Accademic Level	161	92.0	93.1	93.1
	Offered at First Degree Level	2	1.1	1.2	94.2
	Offered at all Accademic Level	10	5.7	5.8	100.0
	Total	173	98.9	100.0	
Missing	System	2	1.1		
Total		175	100.0		

Figure 8. Computational analysis of collated data by SPSS

DISCUSSION

From the computational analysis done using SPSS, the following summaries are arrived at:

a. Approximately one-hundred and fourteen (114) of the approximately one-hundred and seventy five (175) accredited university in Nigeria offers engineering based education.
b. Of the one-hundred and fourteen (114) accredited university offering engineering based education, only approximately twelve (12) dedicates a department to the study of material science.
c. Ten (10) of the twelve (12) universities offering material science, offered it at all academic level.

CONCLUSION

From the statistical analysis of the data set for the number of higher educational institutions offering engineering based education, the following deduction and summaries are arrived at:

1. Only almost negligible numbers of universities offers material science as a separate and important department of engineering education.
2. The lack of investment of intellectual manpower towards the study of material science in the nation's tertiary institutions would have a limiting effect on national industrialisation.
3. The resultant limitation in the study of material science in the higher institution, would limit the research and development of indigenous materials.
4. Lack of research and development of indigenous materials would necessitate the importation of varied industrial materials, thereby harming the nation's economy.
5. One way of ensuring economic diversification through the use of innovatively developed material, is to increase the numbers of material science departments within the higher institution.
6. Establishment of material research institutions in different parts of the country, to study and produce innovative products using indigenous material

7. Creation and enactment of policies and laws that would promote the study and research of materials, especially one of indigenous origin.

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REFFERENCE

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