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Improving Curriculum Content of Electrical/ Electronics Engineering of Polytechnics in North-East Nigeria for Technology Driven Curriculum

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Abstract: The study was aimed at improving the curriculum content of electrical/ electronics engineering of polytechnics in North-East Nigeria for a technology driven curriculum. The purpose of the study was to determine the types of microcontrollers and general content of microcontrollers relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North-East Nigeria. The study adopted a descriptive survey research design. The population of the study was 109, which comprised 60 lecturers and 49 industry supervisors. The entire population was used for the study, hence, no sampling was employed. The instrument used for data collection was a structured questionnaire titled: Questionnaire for Improving Curriculum Content of Electrical/ Electronics Engineering (QICCEEE) developed by the researchers. The instrument was validated by three experts and a reliability of 0.87 was obtained using Cronbach Alpha method. Mean and t-test were used to answer the two research questions and the null hypotheses were tested at 0.05 level of significance. Findings of the study revealed that STMicroelectronics Microcontrollers, Renesas Microcontrollers, NXP Microcontrollers, ON Semiconductor Microcontrollers, Motorola Microcontrollers, and Panasonic Microcontrollers are some of the major types of microcontroller relevant for inclusion into the electrical/ electronics engineering curriculum; Seven clusters of Processor Core, Memory, Digital Input/output, Interrupts, Timer, Communication Interface, and Hardware are the general contents of microcontrollers relevant for inclusion into the electrical/ electronics engineering curriculum. The study recommended among others that government should train electrical/ electronics engineering lecturers of polytechnics in North-East Nigeria in the area of the newly identified curriculum contents.

Keywords: Curriculum content, electrical/ electronics, polytechnics, technology driven curriculum

1. Introduction

The pace of change brought about by new technologies had significantly affected the way people live, work and play worldwide. New and emerging technologies challenge the traditional process of teaching and learning, and the way education is managed. According to Nwanchor (2020), the pace of technological change forces constant evaluation of the teaching and learning process which could be addressed with a dynamic curriculum in which the curriculum takes care of the emerging needs as the technology advances with new improvement. The present application of technology to all the activities of the world confirmed the fact that the use of technologically driven curriculum is becoming an indispensable tool for modern advancement in knowledge and skills. With the present day computerizations of activities in education, the focus is now on introduction of technology in schools at all levels (Folayan and Ibrahim, 2000). Additionally, the inclusion of technology in our education and the national policy on education is highly necessary as we launch into the new millennium and targeting the millennium development goals (Nwanchor, 2020).

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Ezugu, Moses, Amos and Auwal (2019) asserted that the 21st century is symbolized by digital revolution and rapid development in electrical and electronics industry and as information transmission becomes cheaper and better with global communication as well as innovative and enhanced means of teaching and learning in various institutions which has also improved due to advances in electronics. According to Okoro, Kuyoro, Adekunle and Awodele, (2013), the degree of success in meeting the demand of new advancement in electronics does not depend only on the number of skilled service personnel. It depends more on the depth of skills and the degree of their relevance to the prevailing situations in electronics world. The depth and degree of relevance of the skills invariably depend on the curriculum used for training in the programmes. According to Okafor (2007), the planned curriculum is the guiding framework, for the school activities which cover the objectives and contents for teaching and learning, human and material resources, organization, methods and evaluation as it best reflects the needs of the learners and the society. Therefore, the effects and need for inclusion of new technological developments into a planned curriculum to meet with global standard of a technology driven curriculum cannot be over-emphasized.

According to Nnabuike, Aneke and Otegbulu (2016), the activities of a nation's educational system are controlled by its curriculum. Such activities must fall under any or all of the three programmes of curriculum viz; programme of studies, programme of guidance and programme of activities. Obilo and Sanugoleye (2010) is of the opinion that curriculum is the instrument that dictates the affairs of every educational system. Curriculum is the planned and guided experiences and intended outcomes formulated through the systematic reconstruction of knowledge and experience under the auspices of the school for the learner's continuous and willful growth and personal social competence (Mkpa & Izuagba 2009: Obilo and Saugoleye 2010). Cognizance of the fact that no nation develops more than its education and curriculum being the educational container of the nation, its improvement and implementation should therefore be regarded as serious as the curriculum itself. This is because no matter how lofty the curriculum is designed, if it is not effectively implemented, the objective of the education cannot be achieved (Nnabuike, Aneke & Otegbulu, 2016).

However, Nnabuike, Aneke and Otegbulu (2016) regards curriculum as a document which contains the needs of society stated in goals and objectives with arranged content and learning experience that are expected to be transferred to learners for better transformation of the learners and the society. The various meaning given curriculum makes it to be in different kinds such as society-centered and subject-centered curriculum. The subject matter of this discussion embodied both society-centered and subject centered curriculum of the polytechnics.

Ibrahim (2017) opined that the aim of establishing Polytechnics in Nigeria is to train technologists and technicians, with industrial work experience and management skills mainstreaming their practical curriculum, in order to enable students gain on-the-job experience as they undergo the curriculum processes in courses leading to the awards of Certificates, National Diploma (ND), Higher National Diploma (HND) and Advanced Professional Diploma which are relevant to the needs, aspirations and the development of the nation's diverse economy and industries. It is with that hope that such acquired training from polytechnics would lead to the transformation of the country's economy and industrial development. According to Moses, Eljajah, Wakili and Balasa (2018), one of the distinguishing features of Polytechnic education is the strong emphasis on practical skills acquisition. Students who successfully completed the programme after passing prescribed course work, examination, projects and supervised industrial work experience are adequately certified and are referred to as diploma graduates.

The National Board for Technical Education (NBTE, 2012), the organization controlling the administration of Polytechnics in Nigeria, maintains that Polytechnics shall in addition to those general goals of tertiary education have as their specific goals, the following among others; (a) Provide full-time or part-time courses of instruction and training in engineering, other technologies, applied science, business and management, leading to the production of trained manpower; (b) Provide the technical knowledge and skills necessary for agricultural, industrial, commercial, and economic development of Nigeria; (c) Give training and impart the necessary skills for the production of technicians, technologists and other skilled personnel who shall be enterprising and self-reliant (FRN, 2013).

Electrical/ electronics engineering is a course in technical education that equips individuals with specific skills, knowledge, and attitudes to enable them maintain, repair, and construct basic electrical/electronic systems in practice (Nweke, 2017). Basically, Electrical/electronic technology equips student with knowledge, skills and attitudes needed for performance in the field of electrical/ electronics and for gainful employment (Attamah & Dauda, 2017). According to Nweke, (2017) electrical/ electronics technology is an offshoot of technical education program offered in technical colleges, polytechnics, colleges of education (technical) and universities in Nigeria in order to produce technical teachers who will be able to inculcate scientific and technological knowledge to individuals. Hence, electrical/ electronics teachers in polytechnics are expected to inculcate these skills in their students as contained in the curriculum.

The need to include microcontrollers into the curriculum of the electrical/ electronics engineering of the polytechnic cannot be cover emphasized as microcontrollers are one of the fast emerging devices in electronic world that produces accurate results to data and other forms of informations. A microcontroller is an electronic device that can be programmed and has input and output (Czaja, 2012). The use of microcontrollers combined with sensors is widely used to control, facilitate data retrieval, get more accurate data and so on (Kim, Nam & Park, 2004; Reverter, Gasulla & Pallas-Areny, 2004). Reverter, et al (2004) stated that the input from the microcontroller can be connected to various electronic devices including sensors. The sensor detects the desired magnitude then is connected to the microcontroller input. The microcontroller processes the sensor detection results according to the program that has been uploaded to the microcontroller. The results of the microcontroller processing are then released through the output. The output of the microcontroller can be connected to a variety of electronic devices such as monitors, printers, and others (Rajendran & Neelamegam, 2004).

The power of microcontrollers lies in their small size and adaptability. As opposed to fixed digital circuitry, microcontrollers can be programmed to perform many applications and can be later changed when improvement are required. This saves both time and money when a field upgrade is required. It is the job of the engineer to come up with the requirements of the application and select the proper device for the application (Broekman & Notenboom, 2003). With the advances in processing capability, many more applications can be realized today with microcontrollers than ever before, especially due to their low power profile.

It is important to note that a wide array of microcontrollers exist, some rivaling or surpassing the capabilities of full-fledged computers in the 70s, 80s, and maybe even 90s. UV Erasure of microcontroller and ROM are today mostly a thing of the past. With the advent of Flash memory, the microcontroller can be programmed thousands of times without any problems. Also, they incorporate a wide array of modules such Analog to Digital Converters, USB, PWM, and Wireless transceivers, enabling integration into any kind of application (Pont, 2008; Cady, 1997). Indeed, the flexibility of these devices will ensure their incorporation in designs many years into the future.

1.2 Statement of the Problem

Technological advancement and development in microcontrollers have taken place and that has created the need for identification of new contents for inclusion in electrical/ electronics engineering programme of polytechnic Education in Nigeria in order to produce graduates who are competent and relevant in today’s work environment. In order to produce graduates who are competent and relevant in today’s work environment, it is necessary that the training environment in which the learner is trained is a replica of the environment in which he must subsequently work, and the training is carried out in the same way with the same operations, the same tools and the same machines as in the occupation itself (Asukwo, 2018). Sadly, the revised 2010 edition of the curriculum, which is presently in use, do not adequately address new technological development as well as new knowledge, skills, tools and equipment needed for studying and working modern day electronics. This therefore has created a gap in the trade theory and practice components of the curriculum as well as the tools and equipment needed in the study of the new technological developments in electronics.

As measures to keep education and training in tune with knowledge and skills needed in the world of work or to produce graduates who are competent and relevant in today’s work environment, the curriculum for electrical/ electronics education at Diploma level need to be reformed, enriched and updated. This will enhance quality assurance and address observed shortcomings; it will also create a basis for modern skill acquisition and effective training. The major thrust of this study therefore, was to identify and determine new contents in microcontrollers needed for inclusion into the curriculum of electrical/ electronics engineering programme at Diploma level in Nigeria in order to increase the employability of the graduates.

1.3 Purpose of the Study

The main purpose of the study is to improve the curriculum content of electrical/ electronics engineering of polytechnics in North-East Nigeria for technology driven curriculum. Specifically, the study sought to determine:

1. Types of microcontroller relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum
2. The general content of microcontrollers relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum.

1.4 Research Question

1. What are the types of microcontroller relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum?
2. What are the general content of microcontrollers relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum?

1.5 Hypothesis

Ho$_1$: There is no significant difference between the mean response of lecturers and industry supervisors on the types of microcontroller relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum.

Ho$_2$: There is no significant difference between the mean response of lecturers and industry supervisors on the general content of microcontrollers relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum.

2. Methodology

The study adopted a descriptive survey research design. According to Saris and Gallhofer (2014), a descriptive survey research involves the assessment of general opinions using questionnaire and sampling method if need be. The area of this study was North-East of Nigeria. This geopolitical zone is located within latitude 6.26^0 East and longitude 4.92^0 North East of equator. It comprised of Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States. The population of the study was 109 which comprise 60 Lecturers of electrical/electronic from the seven polytechnics offering electrical/electronics engineering and 49 industry supervisors of electrical/electronics works in 33 establishments in North Eastern Nigeria. Due to the manageable size of the population, the entire population was used for the study hence, there was no sampling. Instrument used for data collection was a structured questionnaire titled: Electrical/Electronics Curriculum Content Improvement (EECCI) Questionnaire developed by the researchers. The questionnaire was scaled on a 5-point Likert type scale: of Very Highly Relevant (VHR), Highly Relevant (HR), Moderately Relevant (MR), Slightly Relevant (SR), Not Relevant (NR). The questionnaire was validated by three experts in Electrical Technology Education Department of Modibbo Adama University of Technology Yola, Adamawa State. The reliability co-efficient of 0.87 was obtained for the instrument using Cronbach alpha reliability formula. Mean statistic was used to answer the two research questions and t-test for independent sample was used to test the two null hypotheses at 0.05 level of significance. During the analysis, item with a mean value of 3.50 or above was considered as "Relevant" while those items found with mean values below 3.50 were regarded as "Not Relevant". Any hypothesis with *p* value less than or equal to 0.05 was regarded as significant; otherwise, it was not significant.

3. Result

Research Question 1: What are the types of microcontroller relevant for inclusion into the electrical/electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum?

Table 1 - Mean responses of lecturers and industrial supervisors on the types of microcontrollers relevant for inclusion

		n_l = 60		n_s = 49		N = 109	
S/N	**Sub-Unit Items**	$\bar{x}_l$	σ_l	$\bar{x}_s$	σ_s	$\bar{x}_G$	**Remark**
1.	Cypress Microcontrollers	3.40	1.40	4.22	0.42	3.77	Relevant
2.	Infineon Microcontrollers	3.17	1.45	4.24	0.43	3.65	Relevant
3.	STMicroelectronics Microcontrollers	4.33	0.57	3.88	0.88	4.13	Relevant
4.	Renesas Microcontrollers	4.33	0.60	4.43	0.58	4.38	Relevant
5.	NXP Microcontrollers	4.58	0.50	4.39	0.57	4.50	Relevant
6.	ON Semiconductor Microcontrollers	4.38	0.74	4.12	0.60	4.27	Relevant
7.	Hitachi Microcontrollers	3.17	1.55	4.43	0.50	3.73	Relevant
8.	Motorola Microcontrollers	4.53	0.49	4.27	0.52	4.41	Relevant
9.	Panasonic Microcontrollers	4.43	0.56	4.28	0.46	4.36	Relevant
10.	Microchip Microcontrollers	4.29	0.65	3.47	0.75	3.92	Relevant
	Grand Mean	**4.06**		**4.17**		**4.11**	**Relevant**

$\bar{x}_l$ = Mean response of lecturers, σ_l = standard deviation of lecturers, $\bar{x}_s$ = Mean response of supervisors, $\bar{x}_G$ = Mean of means, σ_s = standard deviation of supervisors, n_l = Number of lecturers, n_s= Number of supervisors, N= Number of Respondents

Table 1 above shows that the Lecturers with a grand mean of 4.06 agreed that almost all items listed are relevant for inclusion into the polytechnics' curriculum to improve its general content in electrical/electronics engineering. In the same vein, the Industrial Supervisors indicated that all of the items are relevant for inclusion into the curriculum of electrical/electronics engineering course in the polytechnic with a grand mean of 4.17. With a grand mean of means of 4.11, both Lecturers and Industrial Supervisors indicated that all of the items are relevant for inclusion into the electrical/electronics engineering curriculum of the polytechnics.

Table 2 - Mean responses of lecturers and industrial supervisors on general content of microcontrollers to be included in electrical/ electronics curriculum in polytechnics

		n_l = 60		n_s = 49		N = 109	
S/N	**Sub-Unit Items**	$\bar{x}_l$	σ_l	$\bar{x}_s$	σ_s	$\bar{x}_G$	**Remark**
Cluster 1: Processor Core:							
1.	Microcontroller Components	4.40	0.72	4.42	0.67	4.36	Relevant
2.	Processor Core Architecture	4.42	0.67	4.04	0.73	4.25	Relevant
3.	Processor Core Instruction Set	4.38	0.69	4.39	0.49	4.39	Relevant

Cluster 2: Memory :							
1.	Volatile Memory	4.33	0.81	4.10	0.77	4.22	Relevant
2.	Non-volatile Memory	4.37	0.71	4.45	0.50	4.40	Relevant
3.	Accessing Memory	4.38	0.67	4.20	0.41	4.29	Relevant
Cluster 3: Digital Input/output:							
1.	Digital Input	4.23	0.79	3.84	0.90	4.06	Relevant
2.	Digital Output	3.45	0.85	3.88	1.24	3.69	Relevant
3.	Digital/Analog Conversion	3.70	1.40	3.81	1.64	3.79	Relevant
4.	Analog Comparator	4.03	1.50	3.49	1.61	3.74	Relevant
5.	Analog/Digital Conversion	4.03	0.60	3.64	0.71	3.86	Relevant
Cluster 4 : Interrupts:							
1.	Interrupt Control	4.45	0.85	4.06	0.56	4.28	Relevant
2.	Interrupt Handling Interrupt Handling	3.80	1.71	4.27	0.45	3.96	Relevant
3.	Interrupt Service Routine	3.33	0.73	3.96	1.04	3.67	Relevant
Cluster 5: Timer:							
1.	Counter	3.97	1.59	3.35	0.48	3.54	Relevant
2.	Input Capture	3.12	1.51	4.24	0.43	3.62	Relevant
3.	Output Compare	4.32	0.85	4.49	0.51	4.39	Relevant
4.	Pulse Width Modulation	4.52	0.50	4.27	0.45	4.40	Relevant
5.	Watchdog Timer	4.43	0.79	4.06	1.09	4.27	Relevant
6.	Power Consumption and Sleep	4.42	0.67	3.49	0.51	3.95	Relevant
7.	Reset	4.50	0.60	4.18	0.72	4.36	Relevant
Cluster 6: Communication Interface:							
1.	Data Transmission	4.45	0.62	4.33	0.47	4.39	Relevant
2.	Speed Control Through Slave	4.60	0.49	4.37	0.49	4.50	Relevant
3.	Multi-Master Mode	4.23	0.53	4.00	0.61	4.13	Relevant
4.	Extended Addresses	4.18	0.70	4.18	0.39	4.18	Relevant
Cluster 7: Hardware:							
1.	Switch/Button	4.03	1.01	3.57	1.08	3.83	Relevant
2.	Matrix Keypad	3.37	1.38	4.18	0.39	3.73	Relevant
3.	Potentiometer	3.05	1.44	4.22	0.42	3.58	Relevant
4.	Phototransistor	4.38	0.58	4.24	0.43	4.32	Relevant
5.	Position Encoder	4.15	0.76	3.71	1.00	3.95	Relevant
6.	Numeric Display	3.52	0.54	4.39	0.61	3.96	Relevant
7.	Multiplexed Display	4.40	0.76	4.35	0.60	4.38	Relevant
8.	Switching Loads	3.88	1.51	4.08	0.67	3.92	Relevant
9.	Basic Principles of Operation	4.48	0.50	4.41	0.50	4.45	Relevant
	Grand Mean	**4.10**		**4.07**		**3.97**	**Relevant**

$\bar{x}_l$ = Mean response of lecturers, σ_l = standard deviation of lecturers, $\bar{x}_s$ = Mean response of supervisors, $\bar{x}_G$ = Mean of means, σ_s = standard deviation of supervisors, n_l = Number of lecturers, n_s= Number of supervisors, N= Number of Respondents

Research Question 2: What are the general content of microcontrollers relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North East Nigeria for technology driven curriculum?

Table 2 shows that the Lecturers considered all the items in cluster 1- 7 as relevant for inclusion into the electrical/electronics engineering curriculum of polytechnics in North-East Nigeria with a grand mean of 4.10. Additionally, the Industrial Supervisors with a grand mean of 4.07 considered all the items in cluster 1 – 7 as relevant for inclusion in to the electrical/electronics engineering curriculum of polytechnics in North-East Nigeria. Furthermore, with a grand mean of means of 3.97, all items in cluster 1 – 7 were considered relevant for inclusion by both categories of respondents.

Hypothesis 1: There is no significant difference between the mean response of lecturers of electrical/electronics of polytechnics and that of industry supervisors on the types of microcontroller relevant for inclusion into the electrical/electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum.

Table 3: t-test analysis on responses of lecturers and industry supervisors on types of microcontrollers relevant for inclusion

S/N	Items	Category	n	$\bar{x}$	σ	df	t	p	Decision
1.	Cypress Microcontrollers	Lecturers	60	3.40	1.40				Significant
		Supervisors	49	4.22	0.42	107	3.963	0.000	

2.	Infineon Microcontrollers	Lecturers	60	3.17	1.45				Significant
		Supervisors	49	4.24	0.43	107	2.015	0.000	
3.	STMicroelectronics Microcontrollers	Lecturers	60	4.33	0.57				Significant
		Supervisors	49	3.88	0.88	107	3.255	0.002	
4.	Renesas Microcontrollers	Lecturers	60	4.33	0.60				Not Significant
		Supervisors	49	4.43	0.58	107	0.837	0.404	
5.	NXP Microcontrollers	Lecturers	60	4.58	0.50				Significant
		Supervisors	49	4.39	0.57	107	1.911	0.049	
6.	ON Semiconductor Microcontrollers	Lecturers	60	4.38	0.74				Significant
		Supervisors	49	4.12	0.60	107	1.993	0.044	
7.	Hitachi Microcontrollers	Lecturers	60	3.17	1.55				Significant
		Supervisors	49	4.43	0.50	107	1.457	0.000	
8.	Motorola Microcontrollers	Lecturers	60	4.53	0.49				Significant
		Supervisors	49	4.27	0.52	107	2.638	0.010	
9.	Panasonic Microcontrollers	Lecturers	60	4.43	0.56				Not Significant
		Supervisors	49	4.28	0.46	107	1.546	0.125	
10.	Microchip Microcontrollers	Lecturers	60	4.29	0.65				Significant
		Supervisors	49	3.47	0.75	107	2.164	0.000	

KEY: ***$\bar{x}$ =Mean, σ = Standard Deviation, n = Number of Respondents, df = Degree of Freedom, t = Observed t-value, p = Probability value (2-tailed)***

Table 3 indicated that the lecturers and industrial supervisors were unanimous in their opinions only on the Renesas and Panasonic types of microcontroller relevant for inclusion into the electrical/electronics engineering curriculum of polytechnics in North-East Nigeria. From Table 3 above, the majority opinion indicated that there was a significant difference between the mean response of lecturers of electrical/electronics of polytechnics and that of industry supervisors on the other types of microcontrollers relevant for inclusion into the electrical/electronics engineering curriculum of polytechnics in North East-Nigeria for technology driven curriculum and as such, the null hypothesis one was rejected.

Hypothesis 2: There is no significant difference between the mean response of lecturers of electrical/electronics of polytechnics and that of industry supervisors on the general content of microcontrollers relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum.

Table 4: t-test analysis on responses of lecturers and industry supervisors on general contents in microcontrollers

S/N	Items	Category	n	$\bar{x}$	σ	df	t	*p*	Decision
1.	**Cluster 1: Processor Core**	Lecturers	60	4.40	0.60	107	1.395	0.166	Not Significant
		Supervisors	49	4.24	0.55				
2.	**Cluster 2: Memory**	Lecturers	60	4.36	0.62	107	1.012	0.314	Not Significant
		Supervisors	49	4.25	0.48				
3.	**Cluster3: Digital Input/output**	Lecturers	60	3.91	0.86	107	1.206	0.231	Not Significant
		Supervisors	49	3.73	0.60				
4.	**Cluster 4 : Interrupts**	Lecturers	60	3.86	0.72	107	1.798	0.075	Not Significant
		Supervisors	49	4.10	0.62				
5.	**Cluster 5: Timer**	Lecturers	60	4.04	0.55	107	1.679	0.096	Not Significant
		Supervisors	49	3.87	0.49				
6.	**Cluster 6: Communication Interface**	Lecturers	60	4.37	0.49	107	1.686	0.095	Not Significant
		Supervisors	49	4.22	0.40				
7.	**Cluster 7: Hardware**	Lecturers	60	3.92	0.69	107	1.759	0.081	Not Significant
		Supervisors	49	4.13	0.53				

KEY: ***$\bar{x}$ =Mean, σ = Standard Deviation, n = Number of Respondents, df = Degree of Freedom, t = Observed t-value, p = Probability value (2-tailed)***

The result presented indicated that the lecturers and industrial supervisors were unanimous in their opinions. Therefore, given by the majority opinion presented, null hypothesis two was upheld implying that there was no significant difference between the mean response of lecturers of electrical/electronics of polytechnics and that of industry supervisors on the general content of microcontrollers relevant for inclusion into the electrical/electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum.

3.1 Findings of the Study

The findings of the study based on research questions and hypotheses that guided the study are as follows:

1. STMicroelectronics Microcontrollers, Renesas Microcontrollers, NXP Microcontrollers, ON Semiconductor Microcontrollers, Motorola Microcontrollers, and Panasonic Microcontrollers are some of the major types of microcontroller relevant for inclusion into the electrical/electronics engineering curriculum.
2. Seven clusters of Processor Core, Memory, Digital Input/output, Interrupts, Timer, Communication Interface, and Hardware are the general contents of microcontrollers relevant for inclusion into the electrical/electronics engineering curriculum.
3. There is significant difference between the mean response of lecturers of electrical/electronics of polytechnics and that of industry supervisors on the types of microcontrollers relevant for inclusion into the electrical/electronics engineering curriculum of polytechnics in North-East Nigeria for technology driven curriculum.
4. There is no significant difference between the mean response of lecturers of electrical/electronics of polytechnics and that of industry supervisors on the general contents of microcontrollers relevant for inclusion into the electrical/electronics engineering curriculum.

4. Discussion of Findings

The finding of the study revealed that Cypress Microcontrollers, Infineon Microcontrollers, STMicroelectronics Microcontrollers, Renesas Microcontrollers, NXP Microcontrollers, ON Semiconductor Microcontrollers, Hitachi Microcontrollers, Motorola Microcontrollers, Panasonic Microcontrollers, and Microchip Microcontrollers are some of the major types of microcontroller relevant for inclusion into the electrical/ electronics engineering curriculum. The finding is in agreement with Okoro, Kuyoro, Adekunle and Awodele (2013) who reported that microcomputer components are an integral part of the system and as such its types and categories must be determined. Buttressing this finding, Moses, Eljajah, Wakili and Idris (2018) asserted that the skills to be possessed by the students must be relevant to the course of instruction and the societal needs. Therefore the need to identify the various types of microcontrollers is paramount.

The findings also revealed that seven clusters of Processor Core, Memory, Digital Input/output, Interrupts, Timer, Communication Interface, Hardware are the general contents of microcontrollers relevant for inclusion into the electrical/electronics engineering curriculum. This finding is in agreement with Moses, Ezugu, Amos and Usman (2019) who reported that microprocessors/microcomputers general content such as Microprocessor based digital system, Intel 8086 programming model, etc are relevant for improving electrical/electronic curriculum. Furthermore, Deshmukh (2005) asserted that microcomputers are applicable everywhere and as such it basic control must be made relevant to the end user.

The finding also revealed that there is a significant difference between the mean response of lecturers of electrical/electronics of polytechnics and that of industry supervisors on the types of microcontroller relevant for inclusion into the electrical/ electronics engineering curriculum of polytechnics in North East Nigeria for technology driven curriculum. This fining is in contrast with Moses, Ezugu, Amos and Usman (2019) who reported that there was no significant difference between the mean score of lecturers and industry supervisors on both (microprocessors/microcomputers) general content and performance objectives for improving electrical/ electronics curriculum in colleges of education in North-East Nigeria. Lkama (2013) also reported that industry supervisors do not always differ their opinion on the skill needs of the students but always craving for more.

Additionally, there is no significant difference between the mean response of lecturers of electrical/electronics of polytechnics and that of industry supervisors on the general contents of microcontrollers relevant for inclusion into the electrical/ electronics engineering curriculum. This finding is in agreement with Ibrahim (2017) who asserted that for divergent views to arise in an issue of general interest, the aim of such an issue has not been laid for all participants to know and as such the views of industry supervisors and industry supervisors where unanimous.

5. Conclusion

This study has identified microcontroller types and general contents which when included in the present curriculum of electrical/ electronics engineering of polytechnics in North-East Nigeria, will help keep education and training in tune with knowledge and skills needed in the present world of work. This will go a long way to produce graduates who are competent and relevant in today's technologically-advanced work environment.

6. Recommendation

In view of findings of the study, the following recommendations are made:

1. The National Board for Technical Education (NBTE) should review the curriculum to include the identified contents and types of microcontrollers.
2. Lecturers should be open to the idea of implementing the new identified microcontroller types and contents.

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