West African Journal of Education, Vol. XXXIX 2019 Page 101-113

West African Journal of Education
Vol. XXXIX 2019 ISSN: 0043-2997
Website: http//www.instituteofeducui.com

Evaluation of the Undergraduate Chemistry Education Programme in Universities in Rivers State, Nigeria

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Abstract

Decline in the quality of graduate teachers necessitated the adoption of the benchmark minimum academic standard (BMAS) by the National Universities Commission in Nigeria. Extant studies on university programmes have focused on minimum academic standards with little or no attention paid to BMAS especially with respect to undergraduate chemistry education programme (UCEP). The study evaluated the UCEP on the basis of staffing, learning environment, library resources, curriculum activities and employers' feedback along with undergraduate achievement in and attitude to chemistry. Descriptive survey design and programme logic evaluation model were adopted. All the three universities in Rivers State were enumerated. Fifty-nine (59) academic staff and 179 undergraduates constituted the sample. Three instruments: Programme Assessment Pack (α =0.86); Undergraduate Chemistry Knowledge Test (r =0.87) and Undergraduate Chemistry Attitude Rating Scale (α =0.70) were used to collect data that were analysed using descriptive statistics and ANOVA (at p<0.05). Staffing (81.3%); learning environment (71.6%); and library resources (66.7%) were found adequate while employers' feedback (33.3%) was inadequate. There was a significant mean difference between the expected and observed resources and activities in the three universities, UOP (0.92 ± 0.77); RSU (1.20 ± 0.87); UOE (0.76 ±1.45). Mean achievement in and mean attitude towards chemistry was 70.47±14.07 and 62.78 ± 5.15 respectively. There was a significant difference (F (2,176) = 3.28) in undergraduate attitude to chemistry while a non-significant difference existed in undergraduate achievement in chemistry among the three universities. The need to improve on certain aspects of the programme to ensure the production of high quality graduate chemistry teachers was recommended.

Keywords: Universities in Rivers State, Undergraduate chemistry education programme, resources, Achievement in and attitude towards chemistry

Introduction

Chemistry is a natural and physical science subject that has a wide application in almost all spheres of human endeavours. The role of chemistry and chemistry education in human capacity development through education, especially science, technology,

engineering and mathematics (STEM), is a well-established locally and internationally (Olson and Riordan, 2012; Hassan, 2016; Eagan, Stolzenberg, Zimmerman, Aragon, Sayson and Rios-Aguilar, 2017; Hazari et al, 2017; Shamsuddin, Arome, Aminu, Isah and Adamu (2017). For several years, there has been considerable national attention given to increasing the talent pool in STEM to address the growing concerns of sustainability in the global economy, and ensure access to highly-paid, highly-rewarding fields for all students (Olson and Riordan, 2012) in spite of the many challenges confronting the field of chemical technology in the Nigerian economy (Hassan, 2016; Shamsuddin, Arome, Aminu, Isah and Adamu, 2017).

The undergraduate chemistry education programme (UCEP) is central to the implementation of the chemistry education component of STEM and the overall national development agenda (FRN, 2004; NUC, 2007). The National University Commission (NUC) provides regulation in the areas of programme resources through the stipulations of the benchmark minimum academic standard (BMAS) and its implementation through periodic accreditation exercises with a view to ascertaining compliance in programme resources and activities including staffing, learning environment, library resources, curriculum activities and employers' feedback (NUC, 2012).

Like previous versions, the BMAS made stipulations on inputs and activities but differred in the approach to implementation, which is outcome-based. According to Barkman (2000) and Wilder Research Foundation [WRF] (2009), programme outcomes are the end results or benefits participants get from a programme which may be intended or unintended, positive or negative.

The UCEP outcomes against which the minimum standards have been benchmarked are the undergraduate achievement in (UAC) and attitude to chemistry (UAtC) which are the focus of this paper. The outcome-based focus of the BMAS corroborates the views of Horn and Mackey (2011) which give credence to an outcome-based approach that encourages continuous improvement which unlocks a path toward the creation of a high-quality students-centric education as against a content-based approach that locks a system into a way of doing things that inhibit innovation. This notwithstanding, the roles of resources in the overall programme implementation cannot be overlooked and has to be given special consideration in the evaluation of such a programme. Availability of resources, according to NUC (2007) is a sine-qua-non for effective and efficient implementation of programmes. Adequate levels of resources must, therefore, be provided in tandem with the intended outcomes of the programme.

Resources such as staffing and learning environment (physical facilities) are adequately benchmarked for universities. Heneman and Timothy (2005) defined staffing as the process of hiring, positioning and overseeing employees in organizations. . Staffing is a composite consideration of academic staff structure, qualification, competence and student ratio,; programme administration, non- academic staff number and staff development programme. Kim and Ployhart (2014) share the view that, an

organization that is adequately staffed will out-perform its contemporaries. Researchers such as Akinsolu (2010), Betts, Zau and Rice (2008), Brewer and Goldherber (2000) have shown that there is a positive correlation between qualification of staff and students' academic performance. There is a need to equip the programme with human capital resource that has high cognitive ability while also taking cognizance of training of staff to upgrade them with the specific competencies required for the job (Ployhart, Van Iddekinge and MacKenzie, 2011).

Learning environment is defined by the United Nations Educational Scientific and Cultural Organization Institute of Statistics (UNESCO/UIS) as the complete physical, social and pedagogical context in which learning is intended to occur (UNESCO/UIS, 2012). The organisation also asserts that learners in a supportive environment have high levels of self-efficacy and self-motivation and use learning as a primary transformative force (UNESCO, 2016). The Organization of Economic Cooperation and Development (OECD) holds that physical learning environment is an influential element in the complex and highly contextualized nature of learning which is characterized by the interactions between the learner, teacher, content, equipment and technologies (OECD, 2013).

Another important set of programme resources include library facilities. The role of the library is multifold as outlined by ranking of intellectual properties and general information management. (Ugeh, 2007; Wilkin 2015; Glitsch and Helmkamp 2017). This may have underscored why the NUC rates library resources significantly high by stipulating 10% for physical library and 8% for e-library out of other resources in the university (NUC, 2012). The commission also asserts that the ultimate test of the quality of manpower produced from a programme is in meeting the minimum level of training for the given discipline. The commission stipulates a form of feedback mechanism from employers to universities, referred to as employers rating of graduates, for which 3% of the total programme is allotted. This is considered in this study as employers' feedback of the graduate of UCEP.

Attitude is commonly considered a determinant of the altitude one can attain in life and in a chosen career. Undergraduates' attitude to chemistry applies to chemistry theory and laboratory tasks taught in the classrooms Abulade (2016). Undergraduates' achievement, attitudes and skills are measurable by a number of assessment procedures which include continuous assessment tests, examinations, student's group projects, attitude survey and other forms of data generation during a given programme cycle.

Planned curricula activities are also essential for the implementation of UCEP . The UNESCO envisages curricula from different perspectives ranging from the societal expectations of the educational systems presented in official formats known intended or written to all other experiences that are significantly impactful on the educational systems but not official (UNESCO, 2016).

In the face of these requirements for a functional UCEP, observations are rife that universities rarely conduct self-evaluation of programmes in a five-yearly curricular review within some specified framework as recommended by the NUC. The same is also the case with the general decline in the standard of chemistry graduate teachers as observed by employers which necessitated the adoption of the BMAS in place of previous versions. Available records show that sufficient and scholarly attention has not been given to studies under the BMAS. This study therefore, evaluates the UCEP on the basis of staffing, learning environment, library resources, curriculum activities and employers' feedback. It also investigates undergraduate achievement in and attitude to chemistry.

The study is undertaken to achieve the following objectives:

i. to determine the levels of adequacy of UCEP staffing, learning environment, library facilities, curriculum activities and employers' feedback in the universities.
ii. to determine undergraduate's achievement in and attitude to chemistry.

The following research questions were addressed:

1. What is the level of adequacy of the UCEP resources (staffing, learning environment and library) and activities (curriculum and employers' feedback) in the universities in Rivers State, Nigeria?
2. Are there significant differences between expected and observed resources and activities in the universities in Rivers State, Nigeria?
3. What is the undergraduate achievement in and attitude to chemistry in the universities in Rivers State, Nigeria?
4. Are there significant differences in undergraduate achievement in and attitude to chemistry among the universities in Rivers State, Nigeria?

Methodology

Descriptive research type and Simple programme logic model were adopted for this study. The variables of this study are resource (staffing, learning environment, library, curriculum activities and employers' feedback); and learning outcomes (undergraduates' achievement in chemistry and attitude to chemistry). The sample size for the study was 179 intact undergraduates. Programme assessment pack (PAP) α=0.86, undergraduate chemistry knowledge test (UCKT) α=0.87 and undergraduate chemistry attitude rating scale (UCARS) α=0.70 were used for data collection. Data collection involved collation of programme records relating to the NUC resource criteria in the universities in Rivers State and rating same according to the NUC manual of accreditation procedure using the PAP. Undergraduates were administered the UCKT and UCARS in order to elicit achievement and attitude data. Data collected were analysed with mean, standard deviation, t-test and ANOVA.

Results

Data analysis was organised and interpreted according to the research questions posed for this study.

Research Question One

What is the level of adequacy of UCEP resources (staffing, learning environment and library) and activities (curriculum and employers' feedback) in the universities in Rivers State, Nigeria?

Table 1: Mean programme resources adequacy in the three universities

NUC criteria	NUC	UOP	RSU	IAUE	Mean	Decision
Staffing	32	28	25	25	26.00(81.25)	Adequate
Learning environment	27	23	18	23	21.33(79.01)	Adequate
Department library	18	10	13	13	12.00(66.67)	Adequate
Curriculum activities	18	16	14	16	15.34(85.22)	Adequate
Employers' feedback	3	1	1	1	1.00(33.33)	Not adequate
Total	98	78	71	78	75.66(77.21)	Adequate

UOP=University of Port Harcourt, RSU=Rivers State University, IAUE=Ignatius Ajuru University of Education

The assumption that any criterion rated below 50% of the NUC rating is considered not adequate was adopted as shown in Table 1. The table presents five categories of criteria with ratings of the programme resources and activities of the three universities in Rivers State vis-à-vis the NUC standards for Nigerian universities. The results show that all the three universities do not meet the minimum stipulations for programme requirements. However, all have ratings sufficient to continue running the UCEP on full clearance mark but may still be on clear standing on interim basis (NUC, 2012). For the purpose of this study and in accordance with the assumption for results interpretation, the three universities, individually and collectively, meet the resource and activities adequacy criteria. The result further shows that employers' feedback was the only criterion rated 33%, below 50% of the standard rating, hence it was declared inadequate as depicted in Figure 1. This shows that the employers feedback activity has not been fully deployed as a veritable indicator of programme performance in the eye of the programme product consumer, the employer. This finding gives credence to the outcome-based approach of the 2007 BMAS where consumer opinion and satisfaction are provided for.

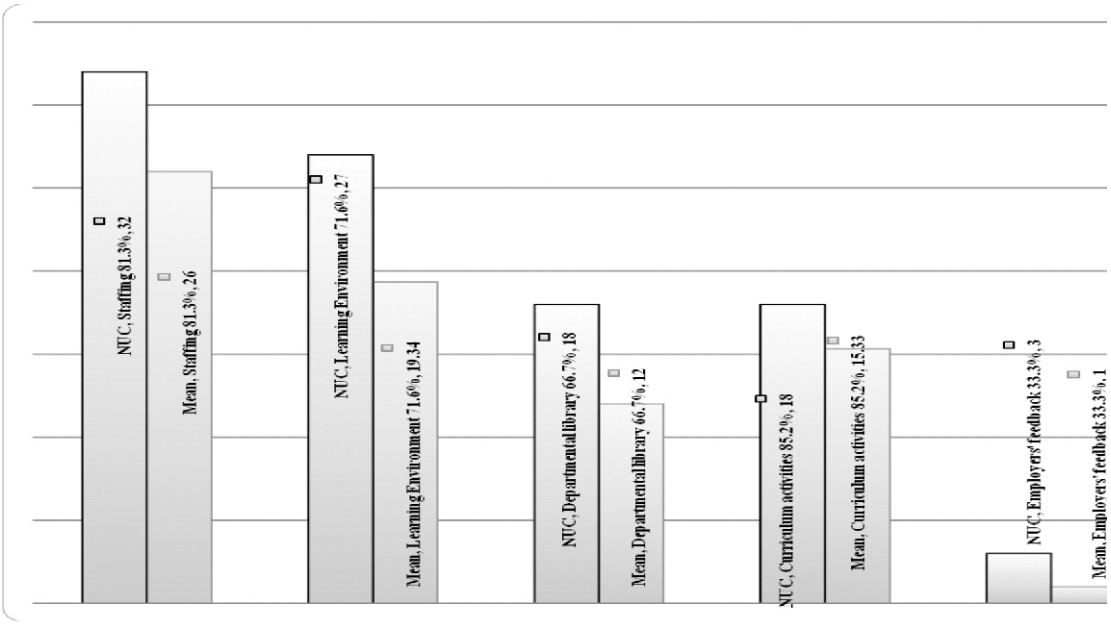

Figure 1: Level of resource adequacy of the universities in Rivers State

Research Question Two

Are there significant differences between the expected and observed resources and activities in the universities in Rivers State, Nigeria?

Table 2: Mean difference between expected and observed universities resources

Dependent variable		N	Mean	SD	df	T	Sig.
Pair 1	NUC	24	3.96	2.39	24	3.40	.002*
	UOP	24	3.04	1.72			
Pair 2	NUC	24	3.96	2.39	24	4.43	.000*
	RSU	24	2.76	1.42			
Pair 3	NUC	24	3.96	2.39	24	3.61	.001*
	IAUE	24	3.20	1.94			

UOP=University of Port Harcourt, RSU=Rivers State University, IAUE=Ignatius Ajuru University of Education

Table 2 shows the mean difference between expected and observed resources and activities in the three universities as depicted in Figure 2. Mean differences exist between the expected and the observed in the universities as follows: UOP (0.92±0.77), RSU (1.20±0.87), UOE (0.76±1.45). These differences were found to be statistically significant at p ⊠ 0.05 as follows: RSU (t_{24} =4.43; p=0.00), UOE (t_{24} =3.61; p=0.00) and UOP (t_{24} =3.40; p=0.00).

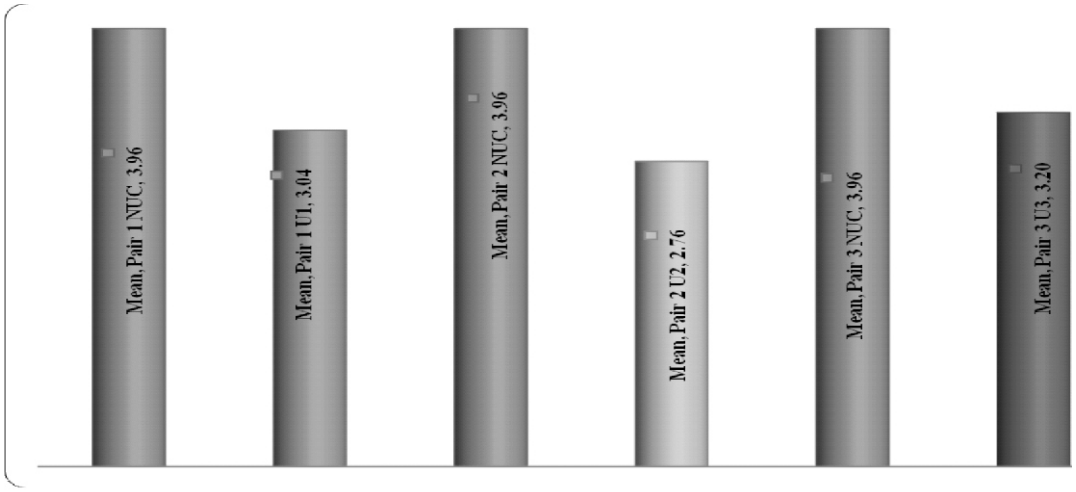

Figure 2: Difference between expected and observed resources and activities

Research Question Three

What is the undergraduate achievement in and attitude to chemistry in the universities in Rivers State, Nigeria?

Table 3: ANOVA of undergraduate's chemistry education p rogramme outcomes

Dependent variable	Universities	N	Mean	SD	Lower	Upper	Min	Max
Undergraduates' achievement in chemistry (UAC)	UOP	40	71.30	15.00	66.50	76.10	50.00	98.00
	RSU	21	65.00	11.90	59.68	70.51	42.00	93.00
	IAUE	118	70.81	14.02	68.25	73.36	44.00	95.00
	Total	179	70.47	14.07	68.17	72.32	42.00	98.00
Undergraduates' attitude to chemistry (UAtC)	UOP	40	61.65	4.94	60.07	63.23	54.00	72.00
	RSU	21	61.05	4.39	59.05	63.05	52.00	70.00
	IAUE	118	63.47	5.24	62.51	64.42	52.00	78.00
	Total	179	62.78	5.15	62.02	63.54	52.00	78.00

UOP=University of Port Harcourt, RSU=Rivers State University, IAUE=Ignatius Ajuru University of Education

Table 3 shows the mean performance of the undergraduates of the programme across the universities in Rivers State and the mean differences of their performances. The table shows that mean undergraduates' achievement in chemistry was 70.47 ± 14.07 with highest score in UOP (mean = 71.56 ± 15.00) and lowest in RSU (mean =65.00 ±11.90). The mean of attitude to chemistry was 62.78±5.15 with the highest in IAUE (mean = 63.47 ± 5.24 and the lowest in RSU (mean = 61.05 ± 4.39).

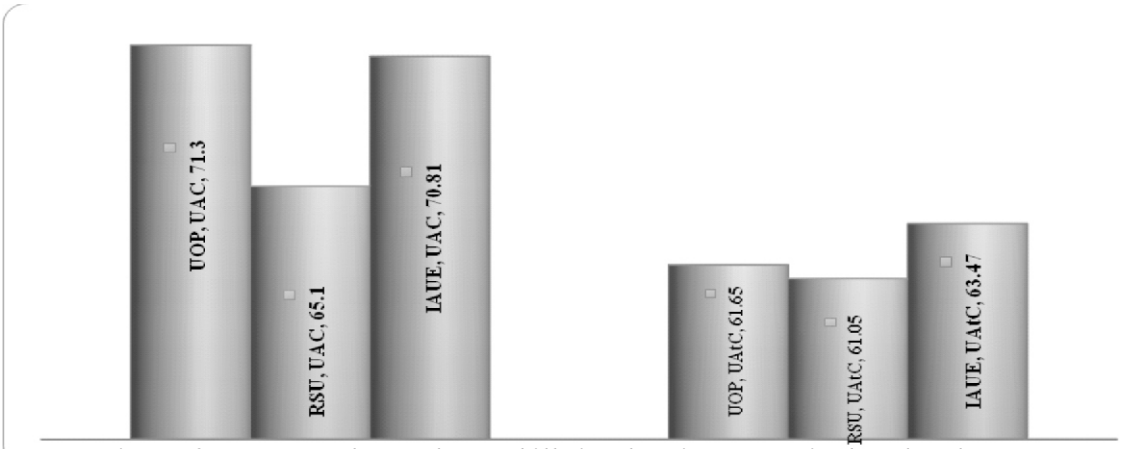

Figure 3: Mean undergraduate skills in chemistry practical and pedagogy

Research Question Four

Are there significant differences in undergraduate achievement in and attitude to chemistry among the universities in Rivers State, Nigeria?

Table 4a: ANOVA of UAC and UAtC among the universities

Dependent variable	Source of variance	Sum of squares	df	Mean squares	F	Sig.
Undergraduates' achievement in chemistry(UAC)	Between	218.14	2	109.07	0.79	0.46
	Within	4284.33	176	138.20		
	Total	4502.47	178			
Undergraduates' attitude to chemistry(UAtC)	Between	169.65	2	84.82	3.28	0.04
	Within	4545.42	176	25.83		
	Total	4715.06	178			

Table 4a shows the ANOVA of UAC and UAtC among the universities. The table shows that non-significant differences existed in UAC ($F_{2, 176}$=0.79, p=0.46), while there were significant differences UAtC ($F_{2, 176}$=3.28, p=0.04) among the universities.

Table 4b: Multiple comparisons

Dependent variable	I	J	MD I-J	SE	Sig.	95% CI interval Lower	Upper
Undergraduates' attitude to chemistry(UAtC)	UOP	RSU	0.60	1.37	0.91	-2.7785	3.98
		IAUE	-1.82	0.93	0.15	-4.1115	.48
	RSU	UOP	-0.60	1.37	0.91	-3.9833	2.78
		IAUE	-2.42	1.20	0.14	-5.3899	.55
	IAUE	UOP	1.82	0.93	0.15	-.4793	4.11
		RSU	2.42	1.20	0.14	-.5529	5.39

UOP=University of Port Harcourt, RSU=Rivers State University, IAUE=Ignatius Ajuru University of Education

Table 4b shows the post-hoc analysis of the ANOVA of UAtC which revealed significant differences among the universities. The table revealed that the highest mean difference is between IAUE and RSU (MD=2.42) and lowest between UOP and RSU (MD=0.60). The table also shows that these differences are not statistically significant.

Discussion

Staffing, learning environment, library resources and curriculum activities were found adequate. The findings of significant mean difference between NUC standard and observed resource profile of the universities, collectively and individually reported, corroborate the findings of Ochu (2007) in which about 50% of the resource requirements were found to be either unavailable or not adequate in an evaluation of the undergraduate chemistry education programme in universities in North-Central Nigeria. The findings also support those of Oni et al (2014) who reported shortfalls in the observed requirements in an evaluation of undergraduate estate management programme in Nigerian universities. Emendu and Okoye (2015) while identifying the problems of studying chemistry in Anambra State spotted infrastructure, curriculum, funding, textbooks, teachers, and students as challenges. Knaub et al (2016), while investigating facilities available for science, technology, engineering and mathematics education, reported situations of unhelpful flexible classroom while Zhu and Engels (2013) reported that students' perception of infrastructure and facilities are factors affecting the smooth implementation of the respective programmes evaluated. This may not be unconnected with weak enforcement of compliance by the regulatory agency who still allows below minimum standard profile for universities to continue running programmes where 'minimum' may have been misunderstood for standard. That understanding needs to be re-echoed and made stringent.

The mean of achievement (UAC) and attitude (UAtC) in chemistry indicate the extent of learning that have taken place amongst undergraduates in the three universities as mean achievement and attitude within the grade levels were considered to be commendable. However, the mean differences found to be statistically non-significant across the universities in Rivers State during the period, 2007-2015, may be due to the fact that no competitive atmosphere existed among the universities to engender such performance differences. Adeyemo, Ogunleye, Oke and Adenle (2010) commented on the falling standards in universities arising from the difference between expected and observed activities in the institutions. The researchers reported that many employers rated certain key skills as particularly worrisome. The findings confirm that universities are still emphasizing "too much theory and too little practical training" which is the reasons why many graduates cannot solve problems or think analytically and are not practically equipped when faced with job situations.

Conclusion and Recommendations

This study was conducted to evaluate the undergraduate chemistry education programme (UCEP) in terms of level of adequacy of resources and activities in compliance with the National Universities Commission's (NUC) subsisting standards and the corresponding outcomes of undergraduate achievement in and attitude to chemistry using four research questions as guides. The study reveals that the UCEP in universities in Rivers State, Nigeria are yet to comply fully with the NUC standard. The study further reveals that, just as the universities still grapple with non-compliance with NUC minimum standards, they do not show significant performance variation in UCEP outcomes. This is not a healthy productive atmosphere for a university community. The study reveals that despite the resources invested in the undergraduate chemistry education programme, the effects of the programme in the universities in Rivers State are significantly low. It is not certain if the programme is able to transmit the needed quantity and quality of manpower to the labour market, since the employers' feedback is reported low in this study. It is therefore recommended that universities should develop a culture of annual *all* graduates' survey which is not a common practice in Nigeria. This will help universities to develop and grow a database of their products and how they are faring after graduation from their respective programmes.

References

Abulude, F. O. 2016. Teachers' and students' attitude towards chemistry in selected secondary schools in Akure South Local Government Area in Ondo State, Nigeria. *Advancing Education in the Caribbean and Africa,* 1st Edition: Chapter: 7, Publisher: Science and Education Development Institute, Nigeria, pp.93-105

Adeyemo, S. A.; Ogunleye, A. O.; Oke, C. O. and Adenle, S. O. 2010. A survey of factors determining the employability of science and technology graduates of polytechnics and universities in the Nigerian labour market. *Journal of Science and Technology Education Research,* 1(5), 99-106

Akinsolu, A. O. 2010. Teachers and students academic performance in Nigerian secondary schools: Implications of planning. *Florida Journal of Educational Administration and Policy, 3(2)*

Barkman, S. J. 2000. *Utilizing the Logic Model for Programme Design and Evaluation.* Purdue University. sbarkman@purdue.edu

Betts, J. R.., Zau, A. C. and Rice, L.A. 2008. *Determinants of Students achievement: New evidence from San Diego,* Public Policy Institute of California, San Francisco, California.

Brewer, D. J and Goldhaber, D. D. 2000. Improving longitudinal data on student achievement: Some lessons from recent research using NELS: 88. In D. W. Grissmer and J. M. Ross (Eds.), *Analytic issues in the assessment of student achievement*. Department of Education. Washington DC

Eagan, M. K.; Stolzenberg, E. B.; Zimmerman, H. B.; Aragon, M. C.; Sayson, H. W. and Rios-Aguilar, H. C. (2017). The American freshman: National norms, fall 2016. *Higher Education Research Institute Report*. University of California, Los Angeles.

Emendu, N. B. 2014. The Role of Chemistry Education in National Development. *The International Journal of Engineering and Science (IJES)*, 3(3), 12-17. ISSN (e): 2319-1813 ISSN (p): 2319-1805 www.theijes.com.

Emendu, N. B. and Okoye, C. M. 2015. Identifying problems associated with studying chemistry in Anambra State, Nigeria. *International Journal of Scientific and Research Publications*, 5(6), 1-7

Federal Republic of Nigeria [FRN] 2004. *National Policy on Education*. Lagos: NERDC Press

Glitsch, S. and Helmkamp, K. 2017. Redefining the role and function of academic library resources in the digital age. The example of readers' services department at Gottingen State and University Library *Libraries at Crossroads: Resolving identities*. Regional Council Meeting. Berlin. 21-22 February, 2017.

Hassan, M. A. 2016. The role of chemistry in Nigerian industries for sustainable development of the nation. *International Journal of Research in Science, 2(2), 29-32.*

Hazari, Z.; Potvin, G.; Cribbs, J. D.; Godwin, A. Scott, T. D. and Klotz, L. 2017. Interest in STEM is contagious for students in biology, chemistry, and physics classes. *Science Advances,* 1-7.

Heneman, H. and Timothy, A. 2005. *Staffing Organizations*. USA. Mc Graw-Hill

Horn, M. B. and Mackey, K. 2011. **Moving from inputs to outputs to outcomes:** *The future of education policy.*www.innosightinstitute.org

Kim, Y. and Ployhart, R. E. 2014. The effects of staffing and training on firm productivity and profit growth before, during, and after the great recession. A monograph. *Journal of Applied Psychology. American Psychological Association, 99(3), 361-389*. DOI: 10.1037/a0035408

Knaub, A. V., Foote, K. T., Henderson C., Dancy, M. H. and Beichner, R. J. 2016. Get a room: The role of classroom space in sustained implementation of studio style instruction. *International Journal of STEM Education,* 3(8), Springer Open. DOI: 1186/s40594-016-0042-3

National Universities Commission [NUC] 2007. Towards effective accreditation of accounting programmes in Nigerian universities. *NUC Official Newsletter,* 8(15): 14-25

National Universities Commission [NUC] 2012. *List of Nigerian Universities and Years Founded.* www.nuc.edu.ng/pages/universities.asp

Ochu, A. N. O. 2007. Evaluation of the undergraduate chemistry education programme in the universities in North-Central Education Zone in Nigerian. *A Ph. D Thesis submitted to the Faculty of Education, University of Nigeria, Nsukka*.

Olson, S. and Riordan, D. G.2012. Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. *Report to the President (Office of the President*).

Oni, A. O., Oloyede, S. A., Ayedun, C. A., and Akinjare, O. A. 2014. Academic standards benchmark and estate management programme in Nigerian universities: Compliance or deviation? *INTED 2014 proceedings, 8th International Technology, Education and Development Conference,* March 10th-1 2th, 2014. Valencia, Spain

Organization for Economic Cooperation and Development [OECD]. 2013. *Innovative Learning Environments*, OECD Publishing, Paris.

Ployhart, R. E., Van Iddekinge, C. H. and MacKenzie, W. I. 2011. Acquiring and developing human capital in service contexts: The interconnectedness of human capital resources. *Academy of Management Journal, 5, 353–368*

Shamsuddin, I. M.; Arome, A. T.; Aminu, I.; Isah, I. I. and Adamu, A. M. 2017. Solving the problems of chemistry education in Nigeria: A panacea for National development. *American Journal of Heterocyclic Chemistry. 3(4), 42-46.* Doi: 10.11648/j.ajhc.20170304.12

Ugah, A. D. 2007. Evaluating the use of university libraries in Nigeria: A case study of Michael Okpara University of Agriculture, Umudike library *Philosophy and Practice* 2007

United Nations Educational, Cultural and Scientific Organization [UNESCO] 2016. *Different meanings of Curriculum.* http://www.unesco.org/new/en/education/

Wilder Research Foundation [WRF]. 2009. *Program theory and logic models. Evaluation resources from Wilder Research.* www.wilderresearch.org

Wilkin, P. J. W. 2015. The meaning of library today. Chapter 11. *The Meaning of library: A Cultural History.* Alice Crawford (Ed.). Princetown University Press. Princetown and Oxford.

Zhu, C. and Engels, N. 2013. Organizational culture and instructional innovations in higher education: perceptions and reactions of teachers and students. *Educational Management Administration and Leadership,* 42(1), 136-158.