Perception of Managers and Chemistry Graduates on Competencies Acquisition of Chemical-Based Industry Employees: Implications for Chemistry Higher Education

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Abstract
For an effective feedback mechanism, there should be regular consultations with employers and alumni of higher institutions for the purpose of reviewing curricula to meet the needs of industry and society. This study was carried out with this perspective. Adopting a descriptive survey design, twelve (12) managers and 103 chemistry graduates from twenty (20) chemical-based industries were used. The managers were interviewed to determine their perspective on competencies (knowledge, skills and attitude) acquisition of the chemistry graduate employees in the various industries while questionnaire was administered to the graduate employees to determine their level of skill acquisition. The responses of the managers were analysed qualitatively and quantitatively using simple descriptive statistics while those of the employees were analysed using paired sampled t-test. The results showed that chemistry graduates working in chemical-based industries acquired adequate theoretical knowledge from the university; they however acquired inadequate skills especially in the use of instruments, production, reporting and management. Many of the managers also claimed that graduates are deficient in the development of a scientific attitude. All the managers agreed that they train their new employees. The findings of the research showed that there is the need for restructuring of the university chemistry curriculum in the area of skill and scientific attitude development, and a need for collaboration between town and gown.

Keywords: chemistry education, chemical-based industries, knowledge, skill, scientific attitude

Introduction

Today's youth need to acquire the knowledge, skills and attitudes that will enable them to create or find jobs as well as cope with unpredictable labour market changes throughout their working lives. According to the International Labour Organisation (ILO, 2000), developing young people's employability is a key policy issue for ensuring the successful transition of youths to the labour market and their access to career-oriented employment. Education plays a crucial role in preparing the youth for the labour market. In the Benchmark Minimum Academic Standards (BMAS) for the Sciences (NUC 1989, 2007), it is observed that training in the science disciplines is the bedrock of technological development and therefore of national growth and maturity with attendant contributions to human welfare, health and progress. Thus, for science graduates in Nigeria to fit into employment opportunities, their training must be relevant and skill-based.

Chemistry is about the very essence of life, the quality of life and its continuous improvement. No wonder the year 2011 was declared by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) as the International Year of Chemistry (IYC), with the theme 'Chemistry: our life, our future'. Chemists are scientists that take one form of matter and make from it a different form of matter. They take raw materials from the earth such as crude oil and convert it to hydrocarbon gases, petrol, kerosene and other petroleum products. They convert iron to steel and convert some forms of matter into fabrics. They can take nitrogen from the atmosphere and convert it to fertilizers (Atkins, 2011). We now take so many of these products for granted; it is easy to forget that without chemical knowledge they would not exist and the economic and national development will be in jeopardy (De Jong, Schmidt, Burger & Eybe, 1999; De Jong, 2000; Chia, 2007).

In the same vein, the chemical-based industry is central to the modern world economy as it converts raw materials (oil, natural gas, air, water, metals and minerals) into different products using chemical processes. Chemicals are used to make a wide variety of consumer goods, as well as thousands of inputs into agriculture, manufacturing, construction and service industries. These chemicals are produced by chemical industries.

Competency and Curriculum Evaluation

Competency can be described as a cluster of related knowledge, skills and attitudes which are required to do a particular job. It can be measured against well-accepted standards and it can be improved via training and development

(Bartram 2004). Thus, competencies can be gained through a multitude of ways: life experiences, formal education, apprenticeships, on-the-job experiences, self-help programmes and also through training and development programmes. According to Anekwe and Obi (2009), a worthwhile curriculum is never static, it is dynamic. Administrators, businessmen, community representative, parents, students and teachers should work together to develop and design the curriculum which should also be subjected to constant review (evaluation). Curriculum evaluation can be defined as a process or cluster of processes that people perform in order to gather data that will enable them to decide whether to accept, change, or eliminate something in the curriculum or an educational textbook (Worthen & Sanders, 1987; Ornstein & Hunkins,2004).These may be undertaken regularly by special curriculum review committees or task forces on the curriculum, or they may be research-based studies on the state and effectiveness of various aspects of the curriculum and its implementation (Odili & Asuru, 2011).

Higher Education, Competencies Acquisition and Employability

There is a range of associated activities which have increased in significance as higher education has expanded and become a greater element in national life. There is no doubt that the concept of higher education has changed from those of Von Humboldt or John Cardinal Newman whose idea was that higher education institutions are enclaves, separate from everyday world; place where students and academics engage in platonic dialogues and where the outcome for both was a deeper understanding of the world and the place they occupy in it. In the recent view of higher education, universities are meant to serve society primarily, by supporting the economy and promoting the quality of life of its citizens. The aim of higher education is to enable society to make progress through an understanding of the world. The Dearing Report (1997) outlined on the "Inquiry into Higher Education", the four main purposes of higher education to include : (i) inspire and enable individuals to develop their capabilities to the highest potential levels throughout life; so that they grow intellectually, become well-equipped for work, can contribute effectively to the society and achieve personal fulfilment; (ii) increase knowledge and understanding for their own sake and to foster their application to the benefit of the economy and society; (iii)serve the needs of an adaptable, sustainable, knowledge-based economy at local, regional and national levels and;(iv) play a major role in shaping a democratic, civilised and inclusive society. Higher education is therefore expected to foster such competencies that would be required for students to become useful to themselves and to the society.

Today's challenging economic situation means that it is no longer sufficient for a new graduate to have knowledge of an academic subject; it is increasingly necessary for students to gain those skills that will enhance their prospects of employment. Fallows and Stevens (2000) opine that employability skills should be built into the higher education curriculum. The skills should be embedded within the academic curriculum for all disciplines. In an exploratory study on the quality of the graduate labour market and the ability of graduates to meet the needs of employers in four European countries, Andrews and Higson (2008) found that employers expected business graduates to possess high levels of discipline-specific skills synthesized with more generic interpersonal and communication competencies. However, most of the graduates stated that they had acquired discipline-specific skills, but lacked the necessary level of presentation skills. Also, Lie, Pang and Mansur (2011) investigated the employer perceptions on graduate literacies in higher education in relation to the workplace. Their findings showed that positive attitudes and mindset were ranked the most important competencies for the work in various organizations. Weinert (1999) holds the view that most key competencies are subject-bound and largely a result of implicit learning processes. He notes that approaches that integrate the acquisition of key competencies into the learning of the subject matter are more promising. Different names are given to these approaches, such as problem-based learning, project-based learning and research-based learning or situated learning. They are student-centred and activity oriented. These learning arrangements are the most favourable for the development of key competencies. These approaches are suggested in the teaching of chemistry for effective learning.

Statement of the Problem

In many countries, there have been concerns expressed about the increasing wide 'gap' between the skills and capabilities of graduates on the one hand and the requirements and demands of the work environment on the other hand (Andrews & Higson, 2008; Zaharim et al, 2009; Santandreu-Mascarell, Canos-Daros & Pons-Morera, 2011). The situation may not be different in Nigeria where higher education has been criticised for not preparing graduates adequately for employability and entrepreneurship (Ajeyalemi, 2002).This would of course have implications on the quality of science graduates produced from Nigerian universities.

Purpose of the Study

The specific objectives of the study are to (i) examine the perception of managers on competencies acquired by chemistry graduate employees of chemical-based

industries (ii) compare the job-required skills of chemical-based industries with those acquired by chemistry graduates from the university chemistry curriculum and (iii) suggest and provide ways on how the gap(s) between job-required and university-fostered competencies can be bridged

Research Questions

The study answered the following questions:

1. What are the perceptions of managers on competencies acquired by chemistry graduate employees of the selected chemical-based industries?
2. What is the relationship between the chemical-based industry job-required skills and the university curriculum acquired skills of the chemistry graduate employees?
3. In what ways could the observed gaps between the chemical-based industries job-required and chemistry graduate-acquired competencies be bridged?

Hypothesis

H_o: There is no significant relationship between chemical-based industry job-required skills and university curriculum acquired skills acquired of the chemistry graduate employees.

Methods

The study adopted descriptive survey and correlation research designs. The population for this study comprised all of the chemical-based industries, chemistry graduate employees and training/quality control managers in Lagos and Ogun States of Nigeria.20 chemical-based industries were randomly selected from the population. A total of 103chemistry graduate employees, irrespective of the designation, years of experience or gender responded to the Chemistry Graduates Required and Acquired Skill Assessment Questionnaire (CGRASAQ), a survey questionnaire that was adapted from the employability profiles outlined for chemistry graduates by Rees, Forbes and Kubler (2006) and the research report of Martin, Villeneuve-Smith, Marshall and McKenzie (2008) on Employability skills. It comprised twenty (20) skills in the psychomotor domain which employers of labour expect of the graduate employees. Twelve (12) Training/Quality Assurance Managers that were available from the 20 chemical-based industries were interviewed following the Interview Guidelines for Training and Quality Assurance/Control Managers. It comprised nine open ended questions.

The instruments were subjected to a reliability test using the Cronbach Alpha reliability statistics. Reliability Statistics of Skill Variables was 0.950.The result from the Cronbach's Alpha based on Standardized Items shows that all the variables have values that are very close to 1; hence the instruments are reliable to use for data collection and statistical analysis.

Results

The analysis of the first three (3) questions on the interview guidelines with Managers was used to answer research question 1: What are the perceptions of managers on competencies acquired by chemistry graduates employees of the selected chemical-based industries?

All the twelve (100%) Managers gave a positive response (Yes) to the question 'Do you train newly employed graduates in your organisation?'

Two outstanding reasons given for the necessity of training are (i) to keep them abreast of the specific operations required / to integrate employees to the industries so as to get the best out of them and (ii) to bridge the gap between theory (knowledge) and practical application (practice).

To the third question 'What are the gaps that exist in the competencies required by your organisations and those that are shown by newly employed chemistry graduates in the following areas?' The responses of the Managers were based on the three areas of competencies (knowledge, skills and attitude).

Knowledge: All the Quality Control/Assurance Managers that were interviewed responded that there is no gap in theoretical knowledge (the course contents from the university chemistry curriculum) required by chemical-based industries and those acquired by chemistry graduates employees. They all agreed that the university chemistry curriculum as is laid out in the NUC BMAS is adequate and broad enough to provide the basic knowledge needed by chemistry graduate employees to work effectively in chemical-based industries.

Skills: All the Quality Control/Assurance Managers also agreed that chemistry graduate employees only acquired theoretical knowledge; they were found lacking in practical application of the theoretical knowledge acquired. On further questioning (interview), one of them had this to say: 'the competency required (to work in the industry) is practical application which manifest in doing; not head knowledge of the concepts and principles'. Some of the examples of areas where the graduates lack adequate skills are that chemistry graduate employees cannot

carry out tests of unprocessed materials and that of finished products. Many of them cannot identify as well as make use of the latest equipment in the industry. In other words, most chemistry graduate employees lack necessary skills.

Attitudes: The Managers also identified gaps in attitude required and those developed chemistry graduate employees. It was generally observed that many chemistry graduates do not take their work seriously; many lack commitment to work while many do not stay long on the job. Some of the Managers opined that the major area where attitude required and acquired tangle is when the issue of money comes in, new graduates seem not to adapt when their aspiration is not met immediately. They move from one industry to another in search of better conditions of service (greener pasture). Some of the managers however attributed the gaps in attitude as individualistic and opined that gaps in attitude could have been as a result of students not having an opportunity to study their own choice of course in the university while those on the job may not have the right motivation from the management of the industries.

Research Question 2: What is the relationship between the chemical-based industry job-required skills and the university curriculum acquired skills of the chemistry graduate employees?

The responses of the respondents are coded from 0 to 3; this makes the two-third of the scale within one standard deviation of the mean 2.00. Therefore, any variable with a mean equal to or greater than 2.00 is considered relevant and required/acquired by the industries; those with mean values between 1.5 and 1.99 are averagely required/acquired while those with means less than 1.5 are considered not too required/acquired by the chemical-based industries. The mean values of respondents' required and acquired skills were calculated. The paired mean differences were also used for further clarification. The calculated mean values are shown in Table 1

Table 1 Mean of Required and Acquired Skills

Skill	Required	Acquired	Mean Difference
Team work	2.960	2.495	0.4654
Communication	2.970	2.584	0.3861
Planning	2.930	2.450	0.480
Organising	2.918	2.510	0.408
Decision making	2.905	2.421	0.484
Leadership	2.867	2.316	0.551
Problem solving	2.959	2.622	0.337
Management	2.735	2.071	0.663
Information Technology	2.604	1.906	0.698
Self Motivation	2.847	2.388	0.459
Innovative Skills	2.847	2.184	0.663
Creative Skills	2.857	2.245	0.612
Time Management	2.960	2.440	0.520
Computer Literacy	2.674	1.888	0.786
Ability to Manipulate Instruments	2.637	1.967	0.670
Investigative	2.833	2.188	0.646
Observational	2.898	2.459	0.439
Production	2.828	1.999	0.838
Quality Control	2.950	2.170	0.780
Entrepreneurial skills	2.464	1.845	0.619

A comparison of the mean values in Table 1 shows that there is a difference between the job-required skills and skills acquired by chemistry graduate employees in chemical-based industries. Furthermore, the values of the paired differences of mean are all positive indicating that the skills required of chemistry graduates working in chemical industries are higher than the skills acquired by them while in the university.

The statistical test for significant difference was carried out by testing the hypothesis formulated using the paired sample t-test.

Table 2: T-test Analysis on Skills Required versus Skills Acquired by Chemistry Graduates

Paired Samples Test	Paired Diff. of Means	**t**	**Df**	Sig. (2-tailed)
	0.580	9.986	101	0.000*

* Significant at $\alpha \leq 0.05$

The sig. (2-tailed) value as shown in Table 2 is less than 0.05. This value signifies that the null hypothesis is rejected. That is, there is a significant difference between skills required by chemistry graduate employees to work effectively in chemical-based industries and skills acquired by them. However, the values of the paired differences of mean are all positive indicating that the skill required of chemistry graduate employees in chemical industries is higher than the skill acquired by them. Thus, it can be inferred that the university chemistry curriculum, though meeting the minimal requirement of the industries, failed to be adequate enough to meet the needs of the industries.

Research Question 3: In what ways could the observed gaps between the chemical-based industries job-required and chemistry graduate-acquired competencies be bridged?

The responses of the Managers on how the gaps can be bridged indicated that:

- there is the need for the chemistry laboratories to be well equipped. Many chemistry graduates cannot identify the instruments used in chemical-based industries let alone operate them.
- lecturers in the chemistry department need to undergo trainings in the use of state of the art equipment and instruments used by chemical-based industries.
- there is the need for a bilateral relationship between chemical-based industries and chemistry departments in Nigerian universities. This can be put to work by encouraging Chemistry lecturers to work in the research department of chemical-based industries periodically so that they can have adequate and current knowledge of what obtains in the industries. At the same time, chemists working in chemical-based industries should be posted to the chemistry departments to assist in the teaching and laboratory works of chemistry students.
- chemistry educators should get project topics from industries for their final-year students. This would help build the Research and Development (R & D) department of the industries.

- the SIWES programme should be well monitored so that both students and the industries can benefit.
- there is the need for restructuring of the curriculum to bridge the gaps in skills and attitudes.

Discussion and Implications of Findings for Chemistry Higher Education

The finding on the perception of chemical–based industries Managers on competencies acquisition of chemistry graduate employees has revealed that there is no gap in required and acquired knowledge but there are gaps in skills and attitude required and acquired by chemistry graduate employees. This is in accordance with the findings of Andrew, Bankole and Olatunde (2000). Thy opined that a large mismatch appears to exist between university output and labour market demands. Their findings showed that the employment prospects of recent graduates have clearly deteriorated. This is due to inadequate levels of skilled human resources, especially the quality of the university-trained portion of the workforce and the weak Nigerian economy. Also, various studies compiled by NESA (2007) showed that 53.2% employers of labour rated as average, products of science and technology education in Nigeria with regard to contemporary challenges in terms of knowledge gained while 42.6% of employers of labour rated the graduates as average in terms of skills acquired and 34.0% rated them below average. These figures are pointers to the need for improvement of the Nigerian education sector not only in chemistry higher education but in all science and technology education.

The finding based on the second research question revealed that chemistry graduate employees skills acquired are below chemical-based industries skills required. An earlier trace study of graduates of the University of Benin from 1980 to 1995 conducted by Omoifo, Badmus, and Awanbor (1997) made an attempt to assess the dimensions of higher education relevant to work and dimensions of work relevant to higher education. Their findings showed that although a high percentage of the graduates (68%) indicated that their positions and statuses were completely appropriate or appropriate, many do not use their acquired skills in employment directly linked to their university training while only 43% of the graduates considered their jobs linked to their studies. Also, the findings revealed that there is an indication of the deterioration of study provisions and conditions in the University. Graduates of Nigerian universities rated supervised practical work and quality of academic advice received as very poor. The graduates felt that teaching facilities and infrastructure were the worst aspects of the university environment, followed by staff qualifications and living conditions. The finding of

this study is an indication that the situation and conditions in the universities are declining and chemistry being an experimental science require well equipped and functional laboratories for practical activities. It should be noted that at the heart of skills acquisition in chemistry is practical work.

The findings from research question 3 on how the gaps identified in competencies of chemistry graduate employees are in agreement with the recommendations made some thirty years earlier by a Science Educator. Ivowi (1985) had highlighted roles which the industries could play in enhancing higher education in the country. They are:

1. Evolve a scheme for research and development efforts in universities, industries and other appropriate institutions
2. Sponsor and contribute towards the establishment of work experience centres in strategic locations in the country
3. Cooperate with appropriate authorities in the establishment of special technical training centres or schools with curricula geared towards solving personnel shortage in identified technological areas of our economy. The services provided by such institutions should be regularly monitored by the industries to ensure relevance and appropriateness all the time.
4. Relevant courses and research should be sponsored in the universities and polytechnics and arraigned in such a way that personnel in industries can move to such places and impart their industrial experience to institutional colleagues in order to generally enrich the curriculum of such establishment. For a start, shares and salaries of such experts from the industries may be endowed by the appropriate industries in order to encourage this type of mobility and opportunity for real development.

He opined that the Nigerian curricular contents appear capable of producing the desired changes but the problem is that of implementation. The industries can play a role in effecting this desired change. The responses of the Managers have reiterated the roles to be played by both universities and the industries. It is high time these suggestions are implemented.

Conclusion

From the research findings, it was discovered that the undergraduate chemistry curriculum is adequate and relevant to the needs of chemical-based industries in terms of course contents. However, the study revealed gaps in skill requirements of chemical-based industries and those acquired by chemistry graduates. There are gaps as well in attitude required and attitude developed by the graduates. Higher

education is not to produce graduates who are vast in theory but inadequate in application of theory learnt. We live in a changing society with greater expectations for the populace and in particular the youth, hence the role and responsibilities of schools and the curriculum will need to change. In line with these expectations, curriculum restructuring becomes vital. Furthermore, if the youths of today would have to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment; the need to move on from the current curriculum becomes apparent because quality content and well-taught subjects can be the vehicle for all of the skills and qualities that they need. It was identified by Busari (2006) that our biggest curriculum challenge is to sustain a desire to learn whilst providing the skills and qualities necessary for young people to influence their own lives.

References

Ajeyalemi, D. (2002). Capacity building in the sciences: Imperatives for Teacher Education in Nigeria. University of Lagos Inaugural lecture series, Lagos: University of Lagos Press.

Andrew, D., Bankole, O., & Olatunde, A. (2000). *Labour market prospects of university graduates in Nigeria.* Nigeria University System Innovation Project.

Andrews, J., & Higson, H. (2008). Graduate employability, 'Soft' skills versus 'Hard' business knowledge: A European Study. *Higher Education in Europe* 33(4), 411-421.

Anekwe, J. U., & Obi, R. O. (2009). Restructuring secondary school curriculum through the integration of information and communication technology best practices. *Journal of Curriculum Organisation of Nigeria* 16(1), 1-6.

Atkins, P. (2011). Where would we be without chemistry? *A World of Science* 9(1), 1-8.

Bartram, D. (2004). Assessment in organizations. *Applied Psychology: An International Review* 53: 237-259.

Busari, O. O. (2006). D*elivery of chemistry education for self – reliance*. Lead paper presented at the Annual conference on delivery of science and technology for self – reliance. Federal College of Education (Tech), Lagos.

Chia, L. H. L. (2007). Chemical education in Singapore. *Chemical Education in Asia – Pacific.* Retrieved from *http://www.t.soka.ac.jp/chem/CEAP/singapore*

De Jong, O., Schmidt, H. J., Burger, N., & Eybe, H. (1999).Empirical research into chemical education. *University Chemistry Education* 3: 28-30.

De Jong, O. (2000). Crossing the borders: Chemical education research and teaching practice. *University Chemistry Education* 4(1), 31-34.

Dearing Report. (1997). *Higher education in the learning society*: Report of the National Committee of Inquiry into Higher Education (HMSO). London: Dearing.

Fallows, S., & Stevens, C. (2000). Building employability skills into the higher education curriculum: A university wide initiative. *Education and Training* 42(2/3), 75-83.

International Labour Organization (ILO). (2000). *World Labour Report: Income security and social protection in a changing world,* Geneva: ILO.

Ivowi, U. M. O. (1985). *Is there need for changing the structure and content of education in Nigeria to suit the needs of industry?* 3rd NECA Advanced course on Manpower Development organized by the Nigeria Employers'

Consultative Association (NECA) at the Federal Palace Hotel, Lagos, Nigeria

Koo Yew Lie, Vincent Pang &Fadhil Mansur. (2011). Employer Perceptions on Graduate Literacies in Higher Education in Relation to the Workplace. *English for Specific Purposes World, www.esp-world.info.*

Martin, R., et al (2008). Employability skills explored. A research report published by the Learning and Skills Network, www.LSNeducation.org.uk

National Universities Commission (1989). *Benchmark Minimum Academic Standards (BMAS) in the Sciences*. Abuja, Nigeria: NUC.

National Universities Commission (2007). *Benchmark Minimum Academic Standards (BMAS) in the Sciences.* Abuja, Nigeria: NUC.

Nigeria Education Sector Analysis (NESA). (2007). Nigerian *Education Sector Diagnosis: A platform for Re-engineering the education sector*. *Synthesis report*. Abuja, Nigeria: Federal Ministry of Education.

Odili, G. A. &Asuru, V. A. (2011). Impact Evaluation of Further Mathematics Curriculum in Nigeria. *Educational Research and Reviews* 6(20), 997-1004.

Omoifo, C., Badmus, G., & Awanbor, D. (1997*). Education and achievement in the early career of the University of Benin Graduates.* Report of 1996 University of Benin Graduates Survey. Faculty of Education, University of Benin. Benin City, Nigeria.

Ornstein, A.C., & Hunkins, F.P. (2004).*Curriculum foundations, principles and issues*. (3rd ed.). Boston: Allyn and Bacon.

Rees C., Forbes P., & Kubler B. (2006) Student employability profiles: A guide for higher education practitioners. *The Higher education Academy*, London: CIHE.

Santandreu-Mascarell, C., Canos-Daros, L., & Pons-Morera, C. (2011). Competencies and skills for future engineers defined in Spanish degrees. *Journal of Industrial Engineering and Management* 4(1), 13-30.

Weinert, F. E. (1999). *Definition and selection of competencies-concepts of competence*. Munich: Max Planck Institute for Psychological Research.

Worthen, B. R., & Sanders, J. R. (eds., 1987). *Educational Evaluation: Theory and Practice*. Worthington, OH: C. A. Jones.

Zaharim, A., et al (2009). A gap study between employers' perception and expectation of engineering graduates in Malaysia. *WSEAS Transactions on Advances in Engineering Education* 6(11), 409-419.