Improving Chemistry Educator’s Subject-Matter Mastery, Pedagogy and Performance through Sandwich Programmes

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Abstract
This paper is a report of research carried out in the United Kingdom, Nigeria and South Africa involving a total of 146 participants. It has become an open cry all over South Africa about the deplorable Physical science matriculation results since the recent years raising such key issues as: inadequate content knowledge acquisition among the educators, deficiency in pedagogical approaches, among others as reasons for the registered poor performance of both educators and learners in Physical science. The study aimed at using the Sandwich programme as one way of solving the observed problems and also improve the quantity and quality of Chemistry educators in the Country given the importance of the learning area in the development of science and technology and hence the economy of any nation. The study employed a mixed method approach involving a Questionnaire on the Application and Effectiveness of Sandwich Programmes for the Improvement of Chemistry Teaching (QAESPICT) and an Interview Schedule to generate data. The data were analysed quantitatively and qualitatively to test two hypotheses and answer the research questions for the study. The findings showed that: two of the three countries used in the study suffered in the long past from similar problems South Africa is facing today regarding educators and learners performance in Chemistry; properly structured sandwich programmes run by the nation’s universities will definitely improve the quality and quantity of Chemistry educators in terms of content knowledge, pedagogy and performance and this is a major recommendation of the study.

Key Words: Chemistry educator, Hands-on-Chemistry activities, Pedagogy, Performance, Sandwich programme and Subject-matter mastery.

Introduction
It is obvious that the quality and pass rate of matriculation results have been on a steady decrease in South Africa since 2003 (DoE, 2010). The observed trend appears to be worse in Mathematics and Physical Sciences among other learning areas. Different personalities in the government including the Minister of Basic Education and the general public have advanced several reasons for the mass failure observed in the 2009 Matriculation Examination results. Some of the probable reasons include: Indiscipline such as truancy among the learners; educators not spending enough quality teaching time with the learners; curricula issues; inadequate content knowledge acquisition among the educators; deficiency in pedagogical approaches; and the scarcity of skilled mathematics and physical science educators, among others. Simkins (2010) observed that part of the way to deal with the issue of mass failure and general underachievement is to deal with the vital issue of the accountability of principals and teachers for the performance of the learners. This implies finding ways to have adequate, qualified and dedicated educators to match up with the expectations of the country in the areas of science and technology and general educational
needs of the learners. These ‘disturbing’ findings may reflect an overall lack of professionalism and motivation among teachers, as well as a high turnover of mathematics and science teachers at many state schools (CDE, 2010). The Centre for Development and Enterprise further noted a gross shortage of maths and science teachers in South Africa and that some of the existing teachers are not adequately qualified. A situation where only 550 potential maths and/or science teachers graduated from South African universities in 2006 (Bernstein, 2007a) calls for a serious concern. This is in spite of the fact that not all of the 550 graduates would end up practising teaching as their profession while there are some more robust employments out there. Bernstein in CDE research: Policy in the making 13 summarized maths and science challenges in South Africa to include the need to:

- increase the numbers of maths and science educators;
- ensure that each educator has a sound knowledge of the curriculum;
- improve the professional development of educators;
- benchmark performance on domestic and international standards; and
- launch programmes specifically aimed at improving pass rates in maths and science, ... (2004, p.241)

All of the above are of significant importance considering the fact that the most vital variable is the educational qualification (content knowledge) of the educators in addition to their teaching skills. A situation where this is lacking apparently affects other variables whose appropriate combinations would bring the expected success to the teaching and learning of the sciences and Chemistry in particular.

Experience has shown that several other countries such as Malaysia, Singapore, China (thestar online, 2009) and Nigeria suffered this kind of problem that is presently plaguing our dear nation, South Africa. Literatures have equally shown some levels of intervention programmes undertaken by such countries which included sandwich courses in all areas that they lacked adequate and quality manpower for the growth of their economies including the education sector.

Sandwich degree courses are courses which include an extra time or year of work experience ‘sandwiched’ between two or three years of concentrated study (Open University and Aimhigher Greater Manchester, 2008). According to euroeducation.net/prof/ukco (2010) some institutions in the United Kingdom have introduced accelerated two-year degrees which require students to study during the normal vacation period. It is expected that the students go on work experience with an employer, organisation or department in their subject areas. This approach to training and further education at higher levels is widely practised in the United Kingdom where would-be students are usually encouraged in their planning process, to provide answers to some basic considerations. They include how the duration will fit into their other plans, would they rather take part-time/sandwich than the full-time degree programme, and so on. UK universities offer over 50,000 different degree courses that can be available as full-time or
part-time (sandwich inclusive) study programmes including Arts, Science, Medicine, Technology and Engineering.

As usual, Part-time and sandwich programmes vary in duration just as the full-time programmes do with respect to entry qualification and nature of courses and modules to be covered before graduation. Furthermore, there are sandwich courses with some undergraduate courses incorporated with periods of industrial training. The duration of study for an Honours Degree is for four years in some full-time programmes having entered at the matriculation level. While some sandwich courses take 3 – 4 years to complete, others take 6 – 8 years (Open University and Aimhigher Greater Manchester, 2008). The main advantage of the sandwich programme is that the student gets real experience while in the learning mode (edstar-country-uk, 2010). Implicit in this, is that such a programme is an `on-the-job` training and will probably add a more lasting experience to the student with increased proficiency on the job at graduation. As an added advantage, all UK courses including sandwich, encourage independence, creativity and self-reliance. These are the kind of qualities that employers look for and chemistry educators all over the world are expected to share from them.

The acceptable norm in UK is that all primary and secondary school teachers must hold first degrees and Postgraduate Certificate of Education (PGCE) awarded by a university or college of higher education (euroeducation.net/prof/ukco, 2010). In other words, they must be have a qualified teacher status as PGCE or Postgraduate Diploma in Education (PGDE) in addition to the first degree. The essence of these requirements is to ensure that the teachers are adequately knowledgeable in the contents and pedagogy of their subjects for effective and meaningful teaching which culminate in effective and meaningful learning.

The Nigerian experience shows that:

“the objectives of the Sandwich Programme are in line with the main objectives of the Faculty of Education.

The main objectives of the Faculty is to produce teachers at graduate and post-graduate levels, who have the mastery of various subjects, combined with a sound academic and professional training in Education. Such teachers, by the end of the programme should be ready to:

a. Teach their chosen subjects effectively in secondary schools, teacher training colleges and tertiary institutions.
b. Infuse creativity into teaching, research and learning,
c. Utilise their specialized training to give leadership in critical assessment and the development of self-discipline.
d. Inculcate in the students the spirit of enquiry and creativity and the ability to think critically and effectively in solving personal and other problems, and add to the existing volume of knowledge in the society.” (Oye, 2007, p. 2 – 3)

The concept of sandwich programme in Nigeria is with focus on the training and retraining of teachers at all levels since having adequate qualified teaching human resources was a big monster facing the educational, scientific and technological growth of the country before the introduction of the programme. According to Jegede (2010), noted that it became a necessity for Nigerian public Universities to introduce sandwich programmes because of the
onus of meeting the ever increasing demand and need for qualified teachers in the country. In other words, the observed high demand for qualified trained teachers as is also the case in South Africa today, is more than what the existing Universities can achieve through full-time programmes only. Reasons for this inability usually include inadequate space and accommodation for classroom and laboratory activities, inadequate availability of facilities and equipment to cater for large numbers of students at a time among others. The need for sandwich programmes is fast spreading into various countries of the world. A total of 1,281 students gained admission into the sandwich programme of the University of Cape Coast, Ghana in 2009/2010 for both undergraduate and postgraduate courses (Naana Opoku-Agyemang 2010). The students were admitted into Business, Physical Science, Social Science, Medical Science, Agriculture and Education as key areas the country is in dire need of qualified manpower. Uluslararasi (2009) opined that teacher education programmes should always encourage parity between the full-time and sandwich or part-time programmes in such areas as entry qualification, course duration and course content. The implications of this need according to Oye (2007) are noticed in the entry requirements as follows:

4-year Programme
a. Passes at credit\merit level in two subjects at the NCE with SSC\GCE ‘O’ level credits or its equivalent in three subjects, including English Language. A pass at NCE general English is acceptable in lieu of Credit pass at the SSC\GCE\O\L.
b. Two passes at the advanced level GCE with SSC\GCE ‘O’ level credit passes in three other subjects.
c. Three passes at the advanced level GCE with SSC\GCE ‘O’ level credit passes in two other subjects.
d. OND with Merit\Credit passes in relevant teaching subjects.
e. Pass at credit\merit level in at least four subjects including English and Mathematics at the SSC\GCE ‘O’ level with any of the following is acceptable for Computer Science Education: Diploma in Data Processing from recognized Universities, ND (Computer Studies) and NCE (Computer Science)
f. Any other relevant qualification approved by the Senate of the University.

5-year Programme
a. Passes at credit\merit level in one major subject in the NCE with SSC\GCE ‘O’ level credit or its equivalent in four subjects including English Language.
b. Passes credit\merit level in two major subjects at the Associate Diploma in Education level with SSC\GCE ‘O’ level credits or its equivalent in three subjects.
c. Passes at the NCE with SSC\GCE ‘O’ level credits or its equivalent in five subjects, including the NCE courses.
d. Passes at credit\merit level in two major subjects in the NCE with SSC\GCE ‘O’ level credit or its equivalent in three subjects.
e. Pass at credit\merit level in at least four subjects at the SSC\GCE ‘O’ level with City & Guilds of London Institute Certificate is acceptable for Computer Science Education.

6-year Programme
a. Passes at credit\merit level in five subjects including English at SSC\GCE ‘O’ level.
b. A credit pass in Mathematics is compulsory for the science based courses.

The South African experience shows that there are a few “Block-release” programmes comparable to the sandwich programmes in some ways, run by a few Universities in the
country. The description of block-release entails the return to further training programmes by participating students during holidays from their normal and official places of work. In the view of the University of Cape Town (2010), educators and students in the 21st century are increasingly harnessing the affordances of information communication technologies (ICTs) to enhance teaching, learning and research at the Postgraduate level. This Postgraduate programme offers teachers, higher education lecturers and educational policy makers the opportunity to develop their theoretical competence and critical insight for using ICTs in education appropriately, focusing specifically on ICTs in developing country contexts. It includes both face-to-face block sessions and online activities and can only be taken on part-time over a one year period for the Post Graduate Diploma in Education and over two years for the Masters in ICTs in Education. Though the programme has a strong emphasis on the theory-practice relationship, it does not focus on the development of practical skills (Cloete and Rabie, 2008).

Young (2007) argued the paramount need for special programmes in areas of special needs including vocational education in South Africa. He stated that through block-release programmes people who were already employed can upgrade their knowledge and practical skills needed for better performance in their employments. This is the same case for physical science and particularly Chemistry where there are a few educators and a big proportion of the few are under-qualified to effectively deliver the teaching to the expectations of the Country and in line with the present day realities. However, it has been observed that very few of such programmes do exist in the Country as against the general acceptance of sandwich programme in the UK, USA, Zambia, Zimbabwe and Nigeria. 

It is of interest to say that curricula contents for both full-time and sandwich or block-release Chemistry education programme should be the same with all collaborating partners from Chemistry and Education departments to ensure that quality graduates are turned out to teach Chemistry in our schools. A number of reasons may explain why professional education and development of Science and mathematics educators has been very low in the past years. They include

- “The generality of low status of FET colleges that may have made the Universities to be reluctant to offer FET – related programmes;

- The absence of link between FET colleges and universities, and between FET teacher education and school-teacher education; and

- Most FET college staff are recruited directly from industry. The emphasis on industrial experience has played down the importance of specialist pedagogical knowledge as the primary qualification ... (Lucas, 2004; Young, 2007)

The above reasons underscored the need to undertake this indebt study. The expectation is that the results of the study will help to champion a better route to improve Chemistry Educators knowledge of the subject and also their pedagogy and practical skills required for improved performance.

**Theoretical framework of the study**

The study adopted the Cultural Factors in Educational Effectiveness: a framework for comparative research by CHENG (2000). According to this framework, countries that show some cultural similarities tend to show relatively similar workability platforms for
developmental factors such as education and industry. History has it that South Africa and Nigeria were once under the colonial government of Britain, whose mode of government must have influenced some cultural factors (including ways of thinking and educational patterns) of the two countries in Africa. Comparing classroom culture and effectiveness, Cheng (2000) indicated that a representative sample of classroom can be selected from each country for the comparative study of classroom culture and its influence on educational effectiveness, particularly at the individual level. This study adapted the approach on Chemistry educators at their individual levels in the three countries used.

**Purpose of the Study:**
This research aimed at comparatively studying the nature, content and execution or implementation of the Chemistry Education sandwich programmes of in Nigeria and UK and the “Block-release” programmes in South Africa. The essence of this task to determine a more workable, improved and efficient programme of training Chemistry Educators vis-a-vis Physical Science Educators for the teaming prospective young scientists and engineers of tomorrow in South Africa.

**Statement of the Problem**
The problem of the study is hinged on the generally observed shortage of qualified Chemistry Educators to effectively teach the learners at the Further Education and Training (FET) band that have chosen Physical Science as a learning area. It was to determine ways of achieving improved and sustained pass rate with proper learning in Physical Science among the learners.

**Research Questions**
The following research questions were answered in the study:
1. Are sandwich teacher education programmes comparable to full-time programmes in terms of curricula content and content coverage?
2. Can sandwich programme be one strong way or approach to producing the much needed Chemistry educators in the country?
3. What is the level of competency and dedication of sandwich Chemistry graduates compared to the full-time products teaching at the high school level?

**Hypotheses**
At $p \leq 0.05$ level of significance, the hypotheses for this study were:
$H_{A1}$: Full-time and sandwich graduate teachers exhibit equal levels of Chemistry and Education knowledge acquired at graduation.
$H_{A2}$: There is a statistically significant difference in pedagogical experience and applications between full-time and sandwich graduate Chemistry educators at the High School level.
Methodology

The design of the study was a mixed type of survey involving both qualitative and quantitative approaches. A total of 146 participants were randomly sampled into two groups of 73 each for Sandwich and full-time graduates teachers respectively. The study involved the collection of Chemistry Education sandwich degree and Block-release curricula from UK, Nigerian and South African Universities and the National Universities Commission. Other useful data and interview results collected using a Questionnaire on the Application and Effectiveness of Sandwich Programmes for the Improvement of Chemistry Teaching (QAESPICT) and an Interview Schedule through the efforts of carefully chosen research assistants and partners. The QAESPICT contained 16 items, 8 of which of modified Likert 4-point scale structure of Strongly Agree, Agree, Disagree and Strongly Disagree responses, 2 were closed-ended dichotomous items, 3 multiple choice items, 2 numerical items and 1 open ended – free comment item. The two instruments were pilot-tested on 10 Science/Chemistry educators in the city of Pretoria, South Africa and the data generated were used to determine an internal consistency reliability value of 0.82 using the Cronbach’s Alpha. 90 copies of the questionnaire were sent out for distribution in the order of 30 copies to each of the three countries of the study, out of which 73 copies (81.11%) came back as completed. The return rate distribution showed that 20(66.67% of 30) came back from Ireland in the UK, 21(70% of 30) were returned from South Africa and 30(100%) were returned from Nigeria. Therefore a total of 73 respondents believed to be teaching Chemistry or related courses were used in this study distributed among high school teachers and lecturers in the tertiary institutions. The research assistants engaged 24 respondents with the interview schedule having 9 items and their responses have been qualitatively analysed in this report.

Data Analysis and Discussion of results

Table 1: Special characteristics of the respondents

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D</td>
<td>5</td>
<td>6.85</td>
</tr>
<tr>
<td>M.Phil.Sc.Ed</td>
<td>2</td>
<td>2.74</td>
</tr>
<tr>
<td>M.Sc.Ed and M.Ed.</td>
<td>9</td>
<td>12.33</td>
</tr>
<tr>
<td>PGDE and PGCE</td>
<td>8</td>
<td>10.96</td>
</tr>
<tr>
<td>B.Sc.Ed (Hons)</td>
<td>41</td>
<td>56.16</td>
</tr>
<tr>
<td>B.Sc (Hons)</td>
<td>6</td>
<td>8.22</td>
</tr>
<tr>
<td>NCE (National Certificate of Education)</td>
<td>2</td>
<td>2.74</td>
</tr>
<tr>
<td>Total:</td>
<td>73</td>
<td>100</td>
</tr>
</tbody>
</table>

Only 6 (8.22%) of the respondents shown in table 1 above do not have training in education courses and are seen as unqualified Chemistry teachers. This further implies that this set of teachers may have the content and subject-matter knowledge but lack the fundamental training in the pedagogy of teaching the subject. Experience has shown that teachers without prior pedagogical training lack some correctional skills required for effective
teacher-student relationship required in the process of Chemistry teaching. The table shows that up to 67 (91.78%) of the respondents are variously qualified to teach Chemistry at different levels. They must have acquired adequate Chemistry and Education content knowledge to equip them in the effective teaching of the subject to the learners. They could have acquired this combined knowledge through the full-time or sandwich/block-release programme.

<table>
<thead>
<tr>
<th>Subjects taught and number of respondents in each subject.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
</tr>
<tr>
<td>Mathematics</td>
</tr>
<tr>
<td>Educational Management</td>
</tr>
<tr>
<td>Biology</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
</tr>
</tbody>
</table>

Table 2 above shows that though the 73 respondents studied Chemistry at one level or the other (Table 1), 65(89.04%) of them were actually involved in teaching Chemistry while 8(0.11%) taught Mathematics, Educational Management and Biology. The picture here lends some credit to the nature of Chemistry and Chemistry Education as being composite. As a physical science, Chemistry requires adequate knowledge of mathematics and every living organism is a part of Chemistry. It is not expected to be a surprise having two of the respondents in table 2 teaching Educational Management because apart from the advances they may have made in the learning area, it must have part of the education courses they did in their Chemistry Education undergraduate programme or at the level of Postgraduate Diploma in Education or its equivalent.

<table>
<thead>
<tr>
<th>Class/Level taught and number of educators/lecturers at each level</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1/Grade 10</td>
</tr>
<tr>
<td>SS2/Grade 11</td>
</tr>
<tr>
<td>SS3/Grade 12</td>
</tr>
<tr>
<td>College/Polytechnic/University</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
</tr>
</tbody>
</table>

Table 3 above shows that only 13 (17.81%) of the respondents in Table 3 above teach above the high school level. In other words, more qualified Chemistry educators are usually required at the high school level for the fact that there are more of such schools with very high teeming population of willing learners across various countries. This is because of the centrality of Chemistry as a subject in virtually every life endeavour and a proper foundation about the subject is expected to be laid at the high school level.

<table>
<thead>
<tr>
<th>Programmes of graduation and number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time</td>
</tr>
<tr>
<td>Weekend</td>
</tr>
<tr>
<td>Sandwich</td>
</tr>
</tbody>
</table>
Table 4 above shows four different programmes through which the respondents graduated from. All the 73 respondents were at their duty posts at the time of this survey and were not applicants. A significant proportion, 38 (52.05%) of the respondents passed through the sandwich programme while 31 (42.47%) passed through the full-time studies. It will mean that if the training and production of Chemistry educators should only be by full-time, a great majority of persons already teaching Chemistry in the schools will remain unqualified. The consequence of this is that results of the Chemistry learners will continue to be poor since the few available spaces for full-time programmes would not be able to cater for the Chemistry educators’ needs of the schools.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Full Time</th>
<th>Weekend</th>
<th>Sandwich/...</th>
<th>ODL</th>
<th>Online</th>
<th>Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Of years</td>
<td>4 yrs</td>
<td>5 yrs</td>
<td>4 yrs</td>
<td>-</td>
<td>1 ??</td>
<td>-</td>
</tr>
<tr>
<td>2 yrs</td>
<td>2 yrs</td>
<td>2 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Programme Type and Minimum number of years

The duration of any programmes is a dictate of the policies of the various countries and universities. However, table 5 above shows four years duration for qualified matriculants and two or three years duration through direct entry after National Certificate for Education or a Diploma programme depending on the quality of the certificate in order to qualify for B.Sc.Ed.(Hons) degree. Weekend Honours degree programme lasts for a minimum of 5 years for candidates with Ordinary Level qualifications. Generally and based on the responses generated for this study, most sandwich and block-release programmes admit candidates with Advanced Level, National Certificate for Education and Diploma certificates for a minimum of four year-straight Honours degree programme. Candidate with distinctions and upper credits at the National Certificate for Education and Diploma levels may be given admission for a two-year straight Honours degree by a few universities through sandwich programme. In the same vein, candidate with good honours degree in any of the science education disciplines may spend two year for a Masters degree and those with sound masters degree may spend a minimum of four years for the doctorate through the sandwich programme too.

Responses from the interview schedule and related items in the QAESP ICT as collected from the respondents were qualitatively analysed and used to answer the research questions of this study as follows:

The first research question sort to find out if sandwich teacher-education programmes are comparable to those of full-time in terms of curriculum content and content coverage and 60 out of the 73 respondents (82.2%) answered ‘Yes’. They stated that the extent of their comparability is particularly in the areas of curriculum content and coverage by lecturers. Their discussions showed that the respondents generally understand what sandwich programme is all about. In a summarised statement they see sandwich programme as a
structure put in place to give opportunities to workers to study while working instead of disengaging from their jobs to do full-time courses. Their responses imply that graduate of sandwich programmes should have covered the same Chemistry and Education course contents though in longer duration as can be compared with their full-time counterparts. All the 73 respondents across the countries of this study shared the same view that their Government Education Departments and National Universities /Colleges of Education/Polytechnics Commissions do not have separate curriculum for sandwich programmes but adopt the same that of the full-time with extended period of study to allow for coverage of the expected contents before graduation. This is imperative because both products of sandwich and full-time programmes are expected as Chemistry educators/teachers to teach the same curricula contents of their countries to their respective learners at their respective levels. In effect, it means that the goal of Chemistry Education is achievable anywhere through full-time or sandwich training and retraining programmes.

The second research question states that: Can sandwich programme be one strong way or approach to producing the much needed Chemistry educators in a country? This question was captured in the interview schedule as item number 6 and all the 24 (100%) interviewees overwhelmingly answered in the affirmative. Asked reason(s) for their answer, they said that it gives government the opportunity to re-train the unqualified Chemistry teachers teaching Chemistry in schools to become qualified. It is necessary to up-grade the content and pedagogical knowledge of Chemistry educators particularly those teaching at the high school level where they are supposed to lay solid foundation of chemical knowledge in the learners for greater achievements and better placements in science and technology courses as the learners graduate in to the universities. Furthermore, the interviewees noted that sandwich programme has the advantages of keeping one’s while on training and putting into immediate practice the newly acquired pedagogical skills as soon as the Chemistry teacher-trainee returns to his/her duty post. It seems that countries such as the UK, Nigeria, Malaysia and a host of others must have reasoned like the respondents to the instruments of this study and adopted the sandwich programme early enough to help solve the problem of shortage of qualified and experienced Chemistry educators in their countries. One of the findings of this study shows that acute shortage of qualified Chemistry educators is one problem still facing South Africa as a country. Sandwich programmes compliment regular programmes which in most cases would not accommodate many students at a time due to insufficient space for the teeming population wanting to enter universities and other tertiary institutions. Sandwich programmers expectedly make use of the facilities and equipment meant for the full-timers when they go on holidays. This approach to training affords the government and other stake holders to a greater number of qualified Chemistry educators than could have been the case with full-time programme only.

The third research question was: What is the level of competency and dedication of Chemistry educators that graduated through sandwich programmes compared to the full-time products teaching at the high school level? 14 (58.3%) of the 24 interviewees rated the competency dedication level of sandwich graduate Chemistry educators as “very good” and the remaining 10 (41.7%) rated the level as satisfactory. The implication of these responses would count on the amount of experiences these sandwich graduates may have acquired through on-the-job training more than the full-time graduates who just find themselves as
new appointees with very little pedagogical classroom and practical experiences. Sandwich students have been found to practice hands-on-chemistry activities than the regular full-time students. This could be as a result of availability of learners and materials to the sandwich students in their duty posts and can always carry out specific hands-on activities with their learners on their return from the periodic sandwich contacts. This approach is one sure way that leads to development and attainment of high level of competency and dedication in the practice of teaching Chemistry. The usual and general statement that ‘practice makes perfect’ is implied here. Comparatively, graduates of the regular programmes depend only the practical activities done during their continuous training programmes and would forgotten some of the necessary skills before or by the time they get employed. This condition appears to be the basis of the suggestion made by many of the interviewees that sandwich programmes even as refresher courses should be made compulsory for all Chemistry educators to keep on advancing in innovative content and pedagogical knowledge from time to time.

**Testing the hypotheses:**
A t-test statistics was used to test the two hypotheses which were stated as: $H_{A1}$: Full-time and sandwich graduate teachers exhibit equal levels of Chemistry and Education knowledge acquired at graduation; and $H_{A2}$: There is a statistically significant difference in pedagogical experience and applications between full-time and sandwich graduate Chemistry educators at the High School level.

**Table 6: Mean, Standard Deviation and t-values**

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Mean</th>
<th>Standard Deviation (SD)</th>
<th>Standard Error</th>
<th>t-Calculated</th>
<th>Critical t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandwich</td>
<td>73</td>
<td>47.63</td>
<td>12.18</td>
<td></td>
<td>2.58</td>
<td>1.96</td>
</tr>
<tr>
<td>1.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>73</td>
<td>25.38</td>
<td>12.18</td>
<td></td>
<td>8.610</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 above shows that the calculated t value of 2.58 is greater than the Critical t value of 1.96 at a degree of freedom of 144 (infinity) at $p \leq 0.05$. This implies significant difference between fresh Chemistry graduates from both sandwich and full-time programmes. The study hypotheses stated above are therefore accepted and the above calculated t value forms a basis to triangulate the qualitative data analysed above. Furthermore, a great proportion of the respondents opined that there is no difference in the amount of Chemistry content knowledge shown by both products of full-time and sandwich/block-release programmes. This invariably underscores the acceptance of the first hypothesis of this study. The acceptance of the second hypothesis by the value of the calculated t is also in agreement with the opinion of majority of the respondents through their responses to the contents of the questionnaire and the interview schedule. This means that practising educators who avail themselves opportunities provided through sandwich programmes have double edged benefits of pedagogical experience and applications. They add to what they used to know and make amends in some cases in the amount of teaching methods, strategies and approaches when they go for their further studies and apply such in their teaching as they return to their duty posts. Undoubtedly, such They add to what they used to know and make amends in some cases in the amount of teaching methods, strategies and
approaches when they go for their further studies and apply such in their teaching as they
return to their duty posts. As a chain reaction, the educators in their new and renewed
dispositions would positively influence the teaching of physical science and Chemistry in
particular such that more of their learners will be passing the subject with better grades. It
further implies that as more Chemistry educators are produced, the higher the matriculates’
pass rate and more of them can then go to the universities for the much needed courses
that are science and technology based.

Conclusion and Recommendations
This study concludes that the dearth of adequate number of qualified Chemistry educators
to teach the subject in the high schools is usually a problem to many nations particularly at
the developmental stage of their educational system. It also showed some clear indications
that many of such nations like Chile, Czech Republic, Indonesia, Nigeria, Korea, Malaysia,
Morocco, Philippines, Thailand, Turkey and Tunisia had similar educational problems, but
like the UK, they adopted various approaches including Sandwich programmes in the areas
of need to salvage the situation. In effect, a properly structured sandwich programme as the
this study has shown has the capacity of producing physical science and Chemistry
education graduates with comparable subject-matter mastery and pedagogical knowledge
as the full-timers but with greater and more efficient performance in the classroom and
laboratory activities. This is an advantage due to the continued practice on the job by the
sandwich students as they return from contact sessions back their places of employment
with additional level of experience.

It is therefore recommended that Sandwich programme should serve as one major
intervention approach directed at the educators in a country such as South Africa for the
gains of the programme. This is in agreement with Bernstein (2004) because the
programme helps to up-grade teachers’ qualifications, exposes them to newer techniques
and methodologies, expand their content knowledge of the subject and eventually increase
their ability to deliver the curricula content of the subject to the learners. This will in turn
improve the learners’ performance in Chemistry, thereby enabling more or them to pass
well at the matriculation examination and can offer such courses at the universities through
which they can contribute positively to the scientific and technological growth and
development of the nation. Furthermore, the introduction of sandwich programme is
usually economical since the limited available materials and infrastructure can be effectively
used in doubling or tripling the quantity of Chemistry educators needed in the system.

References
Bernstein, A. (Ed.) (2004): “From Laggard to World Class: Reforming maths and science
education in South Africa”. CDE Research – Policy in the making 13, Johannesburg:
The Centre for Development and Enterprise, CDE Research no 13, September.
Accessed 05 October, 2010.
challenge in South Africa’S schools”. Johannesburg: The Centre for Development and
Africanus 38 (2) pp. 55 - 76


Open University and Aimhigher Greater Manchester (2008): What are sandwich courses? http://www.aimhigher.ac.uk/uni4me/what_can_i_study_/what_are_sandwich_courses_.cfm Accessed 2010/09/03.

Open University and Aimhigher Greater Manchester (2008): How much time will it take to get a qualification. http://www.aimhigher.ac.uk/uni4me/what_can_i_study_/how_much_time_will_it_take_t_... Accessed 2010/09/03.


Young, M (2007): Improving the Quality of Vocational Education: Some Lessons from
QUESTIONNAIRE ON THE APPLICATION AND EFFECTIVENESS OF SANDWICH PROGRAMMES FOR THE IMPROVEMENT OF CHEMISTRY TEACHING (QAESPICT)

Dear Respondent,

This questionnaire has been constructed for research purposes only to determine the effective use of SANDWICH (CONTACT/BLOCK RELEASE) Programme as one way of solving the problem of inadequate qualified Chemistry educators at the high school level. It is designed to seek information about the present chemistry educators’ subject-matter mastery, pedagogy and performance levels across three countries including South Africa. As an honourably chosen respondent, you are kindly requested to respond to the items of the questionnaire sincerely and without your personal identity. Any information generated from this questionnaire will be treated with level of confidentiality and ethical respects desired.

Please tick (√) where applicable and fill-in the blank spaces as may be required as follows:

1. My qualification(s) is/are : ..............................................................

2. My Area of specialization is : ..............................................................

3. I teach (subject(s) : ..............................................................

4. I teach (a) SS1/Grade 10 /.../(b) SS2/Grade 11 /.../(c) SS3/Grade 12 /.../ students
   (d) At tertiary/University level /.../.

5. I got my qualification(s) through (a) Full-Time /.../ (b) Part-Time Weekend /.../
   (c) Part-Time Sandwich (Contact/Block Release) /.../ (d) Open Distance Learning/.../
   (e) Online /.../ (f) Correspondence /.../ programme.

6. The programme was for .............................................................. years

7. My training programme covered the following areas:
   (a) Physical Chemistry courses only /.../ with /.../ without practicals /.../
   (b) Inorganic Chemistry courses only /.../ with /.../ without practicals /.../
   (c) Organic Chemistry courses only /.../ with /.../ without practicals /.../
   (d) Physical, Inorganic and Organic Chemistry with adequate practical courses /.../
   (e) Some elective courses from Mathematics/Physics/Biology or Life Science/...
   (f) Education courses (Teaching Methods inclusive) necessary for Science Educators training /.../

8. In my own opinion, studying Chemistry Education through the sandwich/ contact/block release covers the same contents as through full-time: Yes /.../ No /.../.

Sandwich/Contact/Block Release programme:

9. is a form of on-the –job training to up-grade the educators` content knowledge and practice. Strongly Agree/.../ Agree/.../ Disagree/.../ Strongly Disagree/.../ I am not sure /.../
10. gives the students the opportunity to always practice the various teaching methods and strategies in their places of work more than the full-time students. *Strongly Agree/...../ Agree/...../ Strongly Disagree/...../ Disagree/...../ I am not sure /...../*

11. is for matured students only. *Yes/...../ No/...../*

12. is preferred in terms of classroom and laboratory management with fewer students than the full-time system. *Strongly Agree/...../ Agree/...../ Disagree/...../ Strongly Disagree/...../*

13. People that pass through the Sandwich/Contact/Block Release programmes have greater opportunities to try out basic Chemistry practical activities on their own. *Strongly Agree/...../ Agree/...../ Disagree/...../ Strongly Disagree/...../*

14. Retention level of Chemistry content knowledge is higher among the Sandwich/Contact/Block Release students than the full-timers. *Strongly Agree/...../ Agree/...../ Disagree/...../ Strongly Disagree/...../*

15. Sandwich/Contact/Block Release programme is inferior to full –time even though it is major approach to raising manpower in most developed countries. *Strongly Agree/...../ Agree/...../ Disagree/...../ Strongly Disagree/...../*

16. Suggest any THREE ways of effectively using SANDWICH (CONTACT/BLOCK RELEASE) Programme as one way of solving the problem of inadequate qualified Chemistry educators at the high school level:

1. ........................................................................................................................................................................
2. ........................................................................................................................................................................
3. ........................................................................................................................................................................

Thank you for taking part in this study.

DATA COLLECTION SCHEDULE FOR THE QAESPICT

<table>
<thead>
<tr>
<th>Item</th>
<th>Responses and No. Of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Qualifications: TCII ( ) NCE ( ) Diploma ( ) HND/HNC ( ) B.Com ( ) B.Ed ( ) B.Sc ( ) B.Sc.Ed (Hons) ( ) B.Sc (Hons) ( ) PGDE/PGCE( ) M.Ed ( ) M.Sc.Ed ( ) Ph.D ( )</td>
</tr>
<tr>
<td>3.</td>
<td>Areas of specialization (list them and state the total number of respondents in each area).</td>
</tr>
<tr>
<td>4.</td>
<td>Subjects taught and number of respondents in each subject.</td>
</tr>
</tbody>
</table>
5. Class/Level taught and number of educators/lecturers at each level:

<table>
<thead>
<tr>
<th>Class/Level</th>
<th>No. of Educators/Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1/Grade 10</td>
<td></td>
</tr>
<tr>
<td>SS2/Grade 11</td>
<td></td>
</tr>
<tr>
<td>SS3/Grade 12</td>
<td></td>
</tr>
<tr>
<td>College/Polytechnic/University</td>
<td></td>
</tr>
</tbody>
</table>

6. Programmes of graduation and number of respondents

<table>
<thead>
<tr>
<th>Programme</th>
<th>Full Time</th>
<th>Weekend</th>
<th>Sandwich/...</th>
<th>ODL</th>
<th>Online</th>
<th>Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Of respondents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Programme Type and Minimum number of years:

<table>
<thead>
<tr>
<th>Programme</th>
<th>Full Time</th>
<th>Weekend</th>
<th>Sandwich/...</th>
<th>ODL</th>
<th>Online</th>
<th>Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Of years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Areas covered by Programme:

(a) Physical Chemistry courses only /...../ with /....../ without practicals /....../
(b) Inorganic Chemistry courses only /...../with /....../ without practicals /....../
(c) Organic Chemistry courses only /...../with /....../without practicals /.../
(d) Physical, Inorganic and Organic Chemistry with adequate practical courses /....../
(e) Some elective courses from Mathematics/Physics/Biology or Life Science/...
(f) Education courses (Teaching Methods inclusive) necessary for Science Educators training/..

8. In my own opinion, studying Chemistry Education through the sandwich/ contact/block release covers the same contents as through full-time: Yes /....../ No /....../.

Sandwich/Contact/Block Release programme:

9. is a form of on-the –job training to up-grade the educators` content knowledge and practice. Strongly Agree/...../ Agree/..../ Disagree/..../ Strongly Disagree/..../ I am not sure

10. gives the students the opportunity to always practice the various teaching methods and strategies in their places of work more than the full-time students. Strongly Agree/...../ Agree/..../ Strongly Disagree/...../ Disagree/...../ I am not sure /...../ 

11. is for matured students only. Yes/...../ No/...../

12. is preferred in terms of classroom and laboratory management with fewer students than the full-time system. Strongly Agree/...../ Agree/...../ Disagree/...../ Strongly Disagree/...../
13. People that pass through the Sandwich/Contact/Block Release programmes have greater opportunities to try out basic Chemistry practical activities on their own.  
   **Strongly Agree/.../ Agree/.../ Disagree/.../ Strongly Disagree/.../**

14. Retention level of Chemistry content knowledge is higher among the Sandwich/Contact/Block Release students than the full-timers.  
   **Strongly Agree/.../ Agree/.../ Disagree/.../ Strongly Disagree/.../**

15. Sandwich/Contact/Block Release programme is inferior to full –time even though it is major approach to raising manpower in most developed countries.  
   **Strongly Agree/.../ Agree/.../ Disagree/.../ Strongly Disagree/.../**

16. Summary of the suggestions made by the respondents:
   ...................................................................................................................................................................
   ...................................................................................................................................................................
   ...................................................................................................................................................................

Name and Address of Research Colleague/Assistant:.........................................................................................

Country:................................Signature:......................................

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**INTERVIEW SCHEDULE**

1. What do you understand by the Sandwich/Contact/Block Release programme in the tertiary institutions?

2. Is the programme comparable to the full-time in terms of content coverage?

3. If your answer is yes to (2) above, to what extent are they comparable?

4. If your answer is no to (2) above, give reasons.

5. Do your Government Education department and the National Universities/Colleges of Education/Polytechnics Commission has different curricula for sandwich and full time programmes?

6. Would you think that sandwich/contact/block release programme is one strong way to produce the much needed Chemistry educators in your country?

7. Give reason for your answer to (6) above.

8. How do you rate the competency level of products of sandwich programmes you handling Chemistry as qualified educators?

9. Freely comment on sandwich/Contact/Block Release programme as a source qualified, dedicated and competent Chemistry Educators.