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Imperatives for Successful Teaching of Chemistry: Implications for Societal Development in the Knowledge Economy

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Abstract

Chemistry plays a critical role in the development of the society. The study investigated the imperatives for successful teaching of chemistry. The study employed a survey research design with two research questions and two null hypotheses to guide the study. The sample size consisted of 21 (male= 13, female= 8) chemistry teachers. One researcher developed instrument tagged "Imperatives for Successful Teaching of Chemistry Questionnaire (ISTCQ)" was used to collect data. The instrument was tested for reliability using Cronbach alpha which yielded a coefficient of 0.83 and the data generated were analysed using mean, standard deviation, ANOVA and t-test. Result revealed that pedagogical content/skills practices, classroom management, communication skill, assessment practices and personal characteristics are very essential for successful teaching of chemistry. The female chemistry teachers irrespective of years of teaching experience considered the imperatives more essential for teaching chemistry than male counterparts.

Keywords: Imperatives for Successful Teaching, Chemistry Education, Chemistry Teachers, Societal Development, Gender.

Introduction

The role of teachers is constantly evolving as the society becomes more complex and digital in this knowledge driven economy. The knowledge economy is the latest stage of development in global economic restructuring and is characterized by the recognition of knowledge as a source of competitiveness; the increasing importance of science, research, technology, and innovation in knowledge creation; and the use of computers and the Internet to generate, share, and apply knowledge (Pedretti,2005). Thus, the knowledge explosion, information and technology advances as well as the skills required for success in a knowledge economy, scientific and technological development calls for national concerns on instructional delivery in Chemistry. Freedman (2010) maintained that the global education imperatives make it necessary for each country to focus attention on how best to achieve and measure greater education inclusion, higher-quality learning and better attainment rates in order to meet social and economic needs of the nation. Teaching is demanding in a variety of ways, and these may include time, effort, commitment and the passion teachers have for teaching. Teachers according to Fraser and Walberg (2005) use various methods such as lecture, small group activities and hands-on learning activities to instruct students, and beyond that, they serve many other roles in the classroom by setting the tone of the

classrooms, build warm environment, mentor and nurture students, become role models, listen and look for signs of trouble among other duties.

According to Darling-Hammond (2000) some variables such as academic ability, years of teaching experience, knowledge of subject matter and teaching knowledge, certification as well as teaching behaviours in the classroom have been examined for their relationship to students' learning and recognized to be indicative of teachers' competence. The means by which teachers' competence in classroom management is related to students' achievement can be through establishing a creative and conducive working environment that would help students cooperate and concentrate on learning tasks. Okebukola (2002) pointed out in benchmark for teaching science that chemistry teachers should possess content knowledge, pedagogical knowledge and pedagogical content knowledge. Pedagogy is the science of teaching which equips the teacher with knowledge, skills and attitude that makes him professional. This could be translated into chemistry teachers creating conducive learning environment through effective classroom management skills, effective communication, support and guide students, use varied assessment strategies and providing timely feedbacks for successful learning of chemistry.

In any formal school setting, assessment is very crucial because it serves as a measure of evaluating the quality of teaching and/or learning that has taken place. Udofia and Etiubon (2009) in their study on challenges and prospects of assessment practices in senior secondary science curriculum noted that teachers' effective assessment in the classroom conveys valuable information about students in the three domains of learning. Masters (2013) suggested that the goal of assessment should be to achieve a greater focus on the approaches and processes of teaching for understanding than being judgmental. Teachers' teaching experience and students' learning has been argued on the fact that experience improves teaching over a period of years. Study on teachers' teaching experience and students' learning outcomes in secondary schools in Ondo State, Nigeria by Adeyemi (2008) showed that years of experience improves teaching skills (pedagogy) while students learn better at the hands of teachers who taught them continuously over a period of years. However, teacher's inability to teach using modern pedagogical techniques and poor classroom interaction in science classroom has been reported by (Udoh, 2008). For teaching to be successful, it must be effective in terms of pedagogical content/skills practices, communication, assessment, classroom management, conducive learning environment and appropriate modeling of professional attitude by the teacher.

Science subjects especially secondary school chemistry and physics according to Hofstein, Eilks and Bybee (2011), seems not to be popular to many students and both subjects are mainly considered as boring and too difficult to comprehend. As a potential solution, chemistry teachers ought to consider certain factors to make instructional delivery more relevant in order to motivate their students and make them curious in the subject.

Ashiakpa (2010) credited poor students' achievement to poor teaching strategies and classroom simulation used by teachers. Ultimately, the goal of teaching is for students to learn meaningfully and acquire knowledge, skills and attitudes needed to function effectively in a scientifically, technologically and socially diversified society. Therefore the imperatives for effective teaching of chemistry needed to be investigated and emphasized.

The teacher plays an important role in the success of students learning. The chemistry teachers according to Njoku (2016) is not the current ordinary teacher but one who is qualified, effective, efficient and competent in teaching. This implies that the chemistry teacher's role in the classroom is more of grasping and utilizing the essential factors that would promote holistic and meaningful learning Nagel (2005) defined a teacher as a professional, holistic developer and classroom manager. A professional teacher in the view of Cochran-Smith (2003), is a facilitator of students' learning who is highly qualified; knows the subject matter to be taught as well as pedagogy which is how to teach the concepts to the understanding of the students. Similarly, Nneji (2005) outlined teachers' responsibilities to include planning (course, unit lesson and extra curriculum activities); controlling, motivating and disciplining students; effectively and appropriately imparting knowledge, assessing pupils progress in knowledge, skill and attitude; sourcing instructional materials and acting professional all the time.

Pedretti (2005) asserted that the fundamental aim of science education, especially chemistry is to equip students to understand and situate scientific and technological developments in their cultural, environmental, economic, political and social contexts. Schooling and indeed teaching of chemistry is therefore being challenged to contribute to the development of the society by engaging students with generic skills, competencies and knowledge. To formulate knowledge and skills that are essential to the economic growth and effective competition within the knowledge drive economy, chemistry teachers have to maximize their hidden potentials and come up with innovative practices in teaching as demanded by the society.

Chemistry education contributes effectively to human and societal development as a socially transforming process that provide knowledge, skills and values through which people can participate in, and contribute to their well-being and that of the society. Chemistry as a science subject helps to address the technological, economic and social objectives of societal development as education is the primary means of empowerment, economic participation, cultural preservation, social mobility and equity. This implies the use of chemicals in modern society in providing solutions to the immediate societal needs such as food security, technology, and industrial development. These can be achieved through effective knowledge and application of chemistry education.

Olubadewo (2007) remarked that chemistry as a discipline is a cure for all societal ailments such as poverty, ignorance, unemployment, improvement in agricultural practices, science and technology development, inventions, discovery and manufacturing. This is

possible because chemistry as a science subject has numerous utility values in all spheres of human activities. The applications of chemistry for societal development are felt in the fields of agriculture, pharmaceuticals, transportation, space science, engineering, industry and the military. Agriculturally, in terms of production of fertilizers, herbicides and drugs. Industrially, in the production of laboratory chemicals, fuels, industrial equipments, arms and ammunitions among others. It is noted that, poor teaching of chemistry with its attendant effect on students' performance in external examinations, could lead to failure in attaining the desired societal technological and economic development (Udofia, 2015). It therefore becomes necessary to examine the imperatives for successful teaching of chemistry by secondary school teachers.

Statement of the Problem

A common survey of Akwa Ibom State School system showed that the secondary schools are filled with a large number of newly recruited teachers. Many of these teachers seem to be deficient of the much needed experience and pedagogical skills that could bring about effective teaching and meaningful understanding by students in the classroom. Hence, teaching, especially of chemistry tends to be done in abstract with no regards to the basics or essential pedagogical skills for successful teaching for enhanced students' performance. The problem of this study therefore is what constitutes the imperatives for successful teaching of chemistry by secondary school teachers in Uyo Municipality, Akwa Ibom State.

Purpose of the Study:

The purpose of the study was to seek the level of opinion of inexperienced, experienced or highly experienced chemistry teachers on the imperatives for successful teaching of chemistry in Senior Secondary Schools in Akwa Ibom State.

Research Questions

One research question guided the study;

1. What are the imperatives for successful teaching of chemistry in Senior Secondary Schools in Akwa Ibom State?
2. Are there any difference between the opinion of teachers (inexperienced, experienced and highly experienced) on the identified imperatives for successful teaching of chemistry in Senior Secondary Schools in Akwa Ibom State?

Null Hypotheses

Ho₁ There is no significant difference in the opinion of highly experienced, experienced and inexperienced chemistry teachers on the imperatives for successful teaching of chemistry.

Ho₂ There is no significant difference in the opinion of male and female chemistry teachers on the imperatives for successful teaching of chemistry

Methodology

The study employed a survey research design. The population of the study consisted of all secondary school chemistry teachers in Akwa Ibom State. From the target population, all the 17 government secondary schools in Uyo municipality were used and all the chemistry teachers who were seen in schools visited gave a sample size of 21 (male= 13, female= 8). One researcher developed instrument tagged “Imperatives for Successful Teaching of Chemistry Questionnaire (ISTCQ)” was used to collect data. The instrument consisted of two sections, A and B. Section A was on demographic factors such as teaching experience and gender while section B contained 55 items on imperatives for successful teaching of chemistry under the sub sections: pedagogical content/skills practices, classroom management practices, communication, assessment practices and personal characteristics with a 3 point response options of Very essential (VE) =3, Essential (ES) = 2 and Not Essential (NE) = 1. The cutoff point was the lower of upper limits of three points: 2.50-3.00 (VE); 1.50-2.49 (ES), 1.00- 1.49 (NE). The instrument was tested for reliability using Cronbach alpha which yielded a coefficient of 0.83. All the 21 copies of the ISTCQ administered were duly collected and data generated were analysed using mean, standard deviation, ANOVA and t-test.

Results

Table1: The Mean Responses on the Imperatives for Successful Teaching of Chemistry in Senior Secondary School Questionnaire (ISTCQ)

| S/N | Imperatives Items | MEA N | SD | RM KS |
|----------|---------------------------------------------------------------------------------------------------|----------|-----|----------|
| A | Pedagogical Content/Skills Practices | | | |
| 1 | Possessing adequate knowledge of subject matter. | 2.62 | .59 | VE |
| 2 | Use of innovative/student centered strategy during instructional delivery to facilitate learning. | 2.86 | .35 | VE |
| 3 | Use of variety teaching resources to create meaningful learning environment. | 2.71 | .56 | VE |
| 4 | Use of action teaching from real life project/authentic task to promote skills acquisition. | 2.81 | .40 | VE |
| 5 | Adequate skills for improvising instructional materials for effective teaching. | 2.67 | .57 | VE |
| 6 | Use of problem based teaching strategy | 2.57 | .59 | VE |
| 7 | Being firmly grounded in knowledge- content skill | 2.52 | .67 | VE |
| 8 | Enhance knowledge construction by using different performance task. | 2.81 | .40 | VE |
| 9 | Uses of role play method to allow students operate in real world situation. | 2.57 | .67 | VE |

| | | | | |
|----------|----------------------------------------------------------------------------------------------------------|-------------|------|-----------|
| 10 | Making explicit link with multiple examples between students' immediate environment. | 2.57 | .51 | VE |
| 11 | Engage students in discussion to clarify misconceptions. | 2.57 | .59 | VE |
| | Cluster mean | 2.66 | | VE |
| B | Classroom Management Practices | | | |
| 12 | Effectively managing disruption during instruction | 2.24 | .70 | ES |
| 13 | Establishing productive teaching environment | 2.71 | .56 | VE |
| 14 | Motivating students with encouraging words | 2.76 | .53 | VE |
| 15 | Fostering positive self concept | 2.67 | .48 | VE |
| 16 | Addressing challenges effectively | 2.76 | .43 | VE |
| 17 | Allowing sufficient time for interaction | 2.71 | .46 | VE |
| 18 | Promoting student-teacher interaction | 2.57 | .50 | VE |
| 19 | Break class into small groups to enhance interactions | 2.48 | .67 | ES |
| 20 | Support students to learn. | 2.54 | .56 | VE |
| 21 | Promote social negotiation among students | 2.67 | .48 | VE |
| 22 | Promote a culturally balance atmosphere in the classroom. | 2.51 | 0.71 | ES |
| | Cluster mean | 2.60 | | VE |
| C | Communication Practices | | | |
| 23 | Communicating using ICT resources. | 2.29 | .56 | ES |
| 24 | Communicating clearly to students understanding. | 2.52 | .51 | VE |
| 25 | Using multimedia to communicate. | 2.10 | .62 | ES |
| 26 | Being creative use users of technology | 2.48 | .60 | ES |
| 27 | Making effective use of available technology | 2.33 | .48 | ES |
| 28 | Use of learning community model | 2.05 | .58 | ES |
| 29 | Guiding students to explore information in the internet. | 1.24 | .62 | NE |
| 30 | Promoting collaboration through digital environment. | 2.24 | .83 | ES |
| 31 | Use of social platforms like whatsapp, Slide Share, blogs and wikis to facilitate digital collaboration. | 1.95 | .49 | NE |
| 32 | Use of appropriate language of science when teaching. | 2.29 | .58 | ES |
| 33 | Promoting gender equality when communicating/teaching. | 2.33 | .65 | ES |
| | Cluster mean | 2.17 | | ES |
| D | Assessment Practices | | | |
| 34 | Use of variety assessment techniques/tools. | 2.52 | .60 | ES |
| 35 | Carrying out regular assessment. | 2.45 | .59 | ES |
| 36 | Use of appropriate domain of assessment. | 2.62 | .58 | VE |
| 37 | Providing students with prompt feedback on tests. | 2.57 | .59 | VE |
| 38 | Using assessment to monitor students' progress. | 2.66 | .57 | VE |
| 39 | Personalizing assessments to establish the level of individual students in their learning. | 2.48 | .60 | ES |

| | | | | |
|----------|--------------------------------------------------------------------------------------------------|-------------|-----|-----------|
| 40 | Using appropriate assessment laboratory activities to measure acquisition of skills of students. | 2.48 | .81 | ES |
| 41 | Keeping efficient records of students' assessment. | 2.71 | .56 | VE |
| 42 | Using assessment as integral parts of the teaching process. | 2.71 | .46 | VE |
| 43 | Promoting gender equality when asking questions. | 2.61 | .58 | VE |
| 44 | Promoting critical thing through tactful questioning. | 2.67 | .48 | |
| | Cluster mean | 2.59 | | VE |
| E | Personal Characteristics | | | |
| 45 | Being a role model to students. | 2.52 | .51 | VE |
| 46 | Showing good humor while teaching | 2.71 | .46 | VE |
| 47 | Having motivating spirit. | 2.57 | .59 | VE |
| 48 | Dressing simple but neat | 2.57 | .59 | VE |
| 49 | Always being punctual to duty | 2.52 | .67 | VE |
| 50 | Showing commitment to work. | 2.61 | .58 | VE |
| 51 | Being a good team player. | 2.43 | .50 | ES |
| 52 | Being proactive in action. | 2.62 | .49 | VE |
| 53 | Being resourceful/creati | 2.76 | .43 | VE |
| 54 | Being enthusiastic. | 2.47 | .51 | ES |
| 55 | Showing commitment. | 2.76 | .43 | VE |
| | Cluster mean | 2.60 | | VE |

From Table 1, 35 items were agreed upon as very essential, 18 as essential and only 2 items were not essential. Items 2, 4, 8, 14, 16 and 55 each had a mean score of 2.86, and 2.76 and above. The result clearly shows that the use of innovative and student centered strategy during instructional delivery was very essential (2.86), enhancing knowledge construction by using different performance tasks and use of action teaching from real life project or authentic task facilitate skills acquisition and learning while items (29 and 31) which were; guiding students to explore information in the internet and use of social platforms to facilitate digital collaboration were not essential. On the whole, deduction from the analysis is that chemistry teachers considered the sub-sections; pedagogical content/skills practices, classroom management, assessment practices and personal characteristics as being very essential for successful teaching of chemistry as shown by the cluster mean scores of 2.66, 2.60, 2.59 and 2.60 respectively while communication was considered essential with cluster mean of 2.17.

Table 2: Descriptive Analysis of Imperatives for Successful Teaching of Chemistry Based on Teachers' Experience

| Teachers' Experience | N | MEAN | Std Deviation |
|----------------------|---|--------|---------------|
| Highly experienced | 8 | 155.25 | 8.66 |
| Experienced | 6 | 151.83 | 5.34 |
| Inexperienced | 7 | 147.14 | 7.95 |

The mean scores shown in Table 2 reveals that highly experience teachers had the highest mean score of 155.25, followed by experienced with 151.83 and inexperienced teachers scored the least of 147.14 in their level of opinion on the identified imperatives for successful teaching of chemistry in senior secondary schools in Akwa Ibom State.

Table 3: One Way Analysis of Variance of Imperatives for Successful Teaching of Chemistry Based on Teachers' Experience

| Source of variance | Sum of Squares | df | Mean square | F-cal | Decision at P<0.05 |
|--------------------|----------------|----|-------------|-------|--------------------|
| Between groups | 245.952 | 2 | 122.976 | 2.114 | .150 |
| Within groups | 1047.190 | 18 | 58.177 | | |
| Total | 1293.143 | | | | |

From Table 3, the findings for null hypothesis one shows that teachers' experience has F-calculated value of 2.114 which is smaller than the table value F-crit of 3.68. , Hence, null hypothesis H_{01} was not rejected. This implies that teachers' experience is not statistically significant.

Table 4: t-Test Analysis of Male and Female Chemistry Teachers Responses on the Imperatives for Successful Teaching of Chemistry

| Variable | Gender | N | Mean | SD | df | t-cal | t-crit | Dec. |
|-------------|--------|----|--------|------|----|-------|--------|----------|
| Imperatives | Male | 13 | 148.69 | 6.79 | 19 | 2.30 | 2.09 | Not sig. |
| | Female | 8 | 156.25 | 8.06 | | | | |

The analysis in Table 4 for hypothesis two has shown that the t –calculated (2.30) is greater than t-critical (2.09) with 19 degree of freedom at .05 level of significance. Hence the null hypothesis two which stated that there is no significant difference in the opinions of male and female chemistry teachers on the imperatives for successful teaching of chemistry is rejected in favour of female which has a higher mean score. Deduction from the analysis is that female chemistry teachers differ in their view from male counterparts on the level of opinion on level of opinion on the imperatives for successful teaching of chemistry in senior secondary schools in Akwa Ibom State.

Discussion of Findings

Result from Table 1 revealed that chemistry teachers agreed to all the sub-sections on the imperatives for successful teaching of chemistry to secondary school students. The result gave credence to what Okebukola (2002) pointed out that teachers should possess content knowledge, pedagogical knowledge and pedagogical content knowledge as benchmark/standard for teaching science. The findings also agree with Nneji's (2005) submission on teachers' responsibilities which include planning (course, unit lesson and extracurricular activities); controlling, motivating and disciplining students; effectively and appropriately imparting knowledge, assessing pupils progress in knowledge, skills and attitude; sourcing instructional materials and acting a professionally at all time. Undoubtedly, pedagogical content/skills practices, classroom management, communication, assessment practices and personal characteristics are the basic roles of a chemistry teacher and which can be employed to engender students' interest and understanding of chemistry.

The findings in Table 2 revealed that there was no statistical difference between highly experienced, experienced and inexperienced teachers. The finding is in agreement with Ogbu (2011) who found that teachers' experience is not a significant factor in enhancing students' achievement. The findings were however consistent with those of Darling-Hammond, (2000) and Adeyemi (2008) students learn more from experienced teachers than they do from less experienced ones .

The results on the testing of null hypothesis two in Table 4 showed that there was a significant difference between male and female chemistry teachers on the imperatives for successful teaching of chemistry, with female teachers obtaining a higher mean score of (156.25) against male with (148.69). This is in support of the assertions of Okebukola (2002) and Ezirim (2006) who asserted that male supremacy and gender stereotyping are among the factors that influence occupational choice. This means that male teachers are not considering certain factors as necessary during instructional delivery.

Implications of the Findings

The implications of the findings of this study are to the extent of facilitating the teachers teaching and students learning of chemistry with concomitant effect on societal development. The teachers' prime role in the classroom is to provide students with varieties of learning experiences through in-depth use of the identified imperatives during instructional de teaching. The findings of the study have implications for effective instructional delivery in the chemistry classroom for enhanced students' performance. Teaching of chemistry will be more interdependence and of interaction between chemistry and the society. Skills for societal participation and competencies for contributing positively to economy and society's development will be ensured.

Conclusion

The knowledge explosions significantly challenge the traditional method of teaching chemistry. Ultimately, the goal of teaching is for students to acquire knowledge, skills and attitudes needed to function effectively in a culturally and ethically diverse society. There must therefore, be changes in the way chemistry teachers teach, manage and assess students. The findings have shown that chemistry teachers need to be more concerned about the factors that promote learning in terms of pedagogical content/skills practices, classroom management, communication, assessment practices and personal characteristics and should be emphasized to make teaching more successful.

Recommendations

The following recommendations are made for successful teaching of chemistry in secondary schools in Akwa Ibom State:

1. The Ministry of Education should organize regular seminars, workshops and conferences for teachers to enhance the pedagogical content knowledge and skills attitude of chemistry teachers.
2. Government should build and equip schools with modern facilities to make classroom conducive for learning.
3. Chemistry teachers should acting professionally and fully incorporated effective pedagogical content/skills practices, classroom management, communication and assessment practices during instructional delivery.
4. Orientation and mentoring programme should be put in place by school administrators and principals for the newly employed chemistry teachers to learn from the experienced teachers.

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