US-China Education Review A 5 (2011) 682-690
Earlier title: US-China Education Review, ISSN 1548-6613

Performance Analysis of Science Education Undergraduates: A Case Study of Biology Education Students*

Chukunoye Enunuwe Ochonogor
University of South Africa, Pretoria, South Africa

The problem of the study was to analyze the results of university biology education students as a case study against gender and performance and empirically determine the implications of the findings to countries, such as Nigeria, South Africa and the rest of the world. The study made use of all the 344 students in the levels from 100 to 400 of B.Sc.Ed. (Hons) (Biology Education Bachelor of Science Education (Honors)) students in the research university. The results showed that there is a significant difference in performance level among biology education undergraduates and between male and female biology education students. Qualitatively, the results showed that the female students are more in biology education as a course and also perform significantly better than the males.

Keywords: biology education, CGPA (cumulative grade point average), gender, performance analysis, proceed, science education

Introduction

Science education has become very central in the emerging globalization of knowledge particularly at the higher education levels. This is because of the observable impact of science and technology on the world of today and the future (Marginson & van der Wende, 2007). Science had become the hub of national growth and when it is well applied, it further boosts technology astronomically without exaggeration. Science in the context of this paper encompasses biology otherwise known as life science (DoE (Department of Education), 2003), chemistry and physics (physical sciences).

The study of biology is usually well embraced especially at the senior secondary and FET (further education and training) levels as a key subject for the study of medicine and other health science courses at the university level. It is, therefore, expected that schools should have adequate number of trained and qualified biology or life science educators to teach this very important subject from the grass-root to the higher levels. Science in general and biology or life science in particular is expected to be humanistic and not gender-biased in nature (Ochonogor, 2006). This implies that irrespective of natural gender differentiation, all learners (old or young) in any given science class are expected to be taught in a common learning environment, using non-stereotyped pedagogical approaches, contents and activities. With such foundation for all recipients of

*Acknowledgements:** I sincerely acknowledge the head of Science Education department, Professor E. A. Inomiesa of the Delta State University, Abraka, Nigeria as the key source of data used in this study. I am also indebted to Mr Ogorode O. Israel and Tetsola Hope that acted as research assistants to the study. Finally, the Institute for Science and Technology Education, University of South Africa, Pretoria is hereby highly commended for providing me the opportunity to interact with South African Life Science educators during their 2009 Winter School Project in the Gauteng Province.
Being a Paper Submitted to the Editor-in-Chief EURASIA Journal of Mathematics, Science and Technology Education.
Chukunoye Enunuwe Ochonogor, Ph.D., Institute for Science and Technology Education, University of South Africa.

science knowledge contents, their performances can, therefore, be evaluated and analyzed on a common platform. The work of Bennett (2003) showed that there are substantial evidences in literature that science is perceived as a "masculine" area of study. This perception has become an age-long one (Aultman, Williams-Johnson, & Schutz, 2009). According to these authors, the present age is becoming more sophisticated than ever and no discriminative perception about knowledge contents or the learners should be allowed to thrive. In other words, science and biology in particular ought to be seen and treated as a discipline for male and female students alike. This is closely supported by the conclusion that there are no biological, neurological or genetic factors at work in the creation of scientific gender disparity (How to attain gender equity in science classroom, 2010). However, a number of combinable factors, such as social stigma of the sciences as "masculine", institutional bias in the scientific community and the need to quickly start and maintain one's immediate family of procreation, could be sources of such disparities.

Bishop, Berryman, Cavanagh, and Teddy (2009) noted that the removal of all observed disparities depends on the teaching methods of the teachers and the policies of the governments. It means that a proper and generic academic performance and achievement of students must depend on teacher effectiveness, educational objectives and hence the outcomes of education. Contributing to how to attain gender equity in science classroom, "How to attain gender equity in science classroom" (2010) observed that a well-crafted curriculum with emphasis on the scientific components of a general education will help students of all backgrounds (male or female) to explore their interests in the scientific world at the stage where new careers can be rekindled. The essence of this is to help produce the number of male and female (in the right proportions) graduates, such as biology or life science education student-teachers for sustained improvements in the quality of classroom teaching and learning of biology or life science in the nation (Westbrook, Shah, Durrani, Tikly, Khan, & Dunne, 2009). Evaluating and analyzing science students' results at the different levels of education generally provide proofs of right or wrong and what the present situation is.

Performance of an individual in any given task points to the person's level and degree of effort put towards the accomplishment of the task. The quality of students' performances in any field of learning is subject to several indices. These include and are not limited to teacher, learner and environmental factors. This study assumed the same teacher and learning environmental factors for all the participants of the case study. This implied that the students were taught by the same set of lecturers in the various biology education courses and levels of four-year full-time B.Sc.Ed. (Hons) programme. The central position of performance analysis in any educational system can never be overemphasized. APU (Assessment of Performance Unit) (1989) in the United Kingdom noted that performance assessment helps to provide indicators for educational standards and the changes that may occur with time. This is in agreement with the findings of Carie (2009) in a recent study on evaluating college students' evaluations of a professor's teaching effectiveness across time and instruction models. Students offer courses of their choice with the aim of accomplishing their life dreams by the end of the training. By this, biology education students like every other student in other disciplines must have chosen to read the course. Expectedly, the students should perform well in the final analysis, but the opposite appears to be the case. The NSTA (National Science Teachers Association) (2010) showed a strong backing for the institution of gender equity at all levels of science classroom. Gender equity implies ensuring that all boys and all girls—irrespective of age, ethnic, cultural affiliations, or disabilities, have equal access to becoming successful and fulfilled scientists and science educators.

It follows, therefore, that the need for this study is strictly professional. It will show the implications of the

students' performance in biology education in particular and science education in general, empirically. The results of the study will add to the growing body of knowledge in science education practices for science and biology or life science educators, institutions of higher learning, departments of education and the general public.

Hypotheses for the Study

The study was guided by the following hypotheses at a level of significance 0.05:

H_{A1}: There is a significant difference in performance among biology education students in the teacher education programme;

H_{A2}: There is a significant difference in performance level between male and female biology education students in the teacher education programme.

Research Methodology

The ex-post-facto design was employed in this study. This was because the needed data already existed in the sample school and were collected directly from the departmental head. This form of design seemed appropriate for the study because of its ability to operate within organismic variables and the need not to randomize the sample but using the entire population of studying to become biology teachers. The research was one of a case study in which Delta State University, Abraka, Nigeria was used. This university's way was chosen for effective monitoring by the author's research assistants of the actual student population and sample for the study. It also afforded the author the needed opportunity through the research assistants to monitor such factors as lecturers that taught the expected courses in the programme. The sample of the study was an intact one as all the 344 students from 100 to 400 levels were used with their performance levels as shown in Table 1.

Table 1

Collection of Result Analysis in 2006/2007 Session for B. Sc.Ed (Hons.) Biology

Level	Male	Female	Total
100: Proceeded	7	14	21
Probated	2	3	5
Withdrawn	-	-	-
Sub-Total (T1)	9	17	26
200: Proceeded	10	22	32
Probated	-	5	5
Withdrawn	-	1	1
Sub-Total (T2)	10	28	38
300: Proceeded	47	98	145
Probated	-	1	1
Withdrawn	-	1	1
Sub-Total (T3)	47	100	147
400: 1st Class (Hons)	-	-	-
2-1 Class (Hons)	4	3	7
2-2 Class (Hons)	14	47	61
3rd Class (Hons)	6	9	15
Pass degree	-	-	-
FRNS/Not Graduating	12	38	50
Sub-Total (T4)	36	97	133
Grand total: (T1 + T2 + T3 + T4)	102	242	344

Note. Source: Science Education Department, Delsu, Abraka, Nigeria.

Table 1 shows that the sample University enrolled and presented a total of 344 biology education students composed of 102 males and 242 females in the various levels of its B.Sc.Ed. (Hons.) degree programme for the 2006/2007 session and their performance as documented in the department. It can be quickly observed from the table above that the ratio of male to female biology education students is approximately 1:2. An oral probe into the mode of admission by which the university got the students showed three sources of students' admission into the institution. Some were as graduates of the university's PD (pre-degree) programme, and some others came through the JAMB (Joint Admissions and Matriculation Board) have passed the yearly UME (university matriculation examinations), while the third group of students were admitted through DE (direct entry). It was further revealed that the DE candidates started from 200-level on admission having qualified with a two-year university diploma or three-year NCE (Nigerian Certificate in Education) with a minimum of merit grade. The educational system of the country, according the National Policy on Education of 2004, showed a six-three-three-four system. This means six years primary school programme, three years junior secondary high school education, three years senior high school education and four years university education meant for high school-leavers who have not less than five credits including English language and/or mathematics and have also passed the UME.

Table 1 further showed some terms which have been explained in this section in accordance with the NUC (National Universities Commission) (2005) of Nigeria. Students that qualified to proceed are those having GPA (grade point average) of 1.00 and above on a five-point grading scale at the end of a given session. A student will be on probation if he/she scores less than 1.00 GPA at the end of a session for the first time. This implies that the candidate must register the failed course(s) first and then make up the approved number of units or credit load from the level's course(s). A candidate was advised to withdraw from a particular degree programme as he/she may have scored less than 1.00 CGPA (cumulative grade point average) in the following session after the first probation. The group of candidates that failed to obtain a minimum of 90 units for those that entered through DE or 120 units for those that entered through PD or UME in their final (400-level) year of the degree programme fall under FRNS (faculty requirements not satisfied) or not graduating.

Analysis of Data

It should be noted that the data used in this study were collected with special clearance from the university for research purposes only. The two hypotheses for the study were tested through the analysis of the data collected. Chi-square (x^2) statistics was used to analyze hypothesis one and the *t*-test ratio was used on the second hypothesis.

Table 2

Observed and Expected Number of Students Proceeding to the Next Level

Level	No. observed (o)	No. expected (e)
100	21	26
200	32	38
300	145	147
400	83	133
Grand total	281	344

The Tables 2 and 3 show the numbers of students that passed to proceed with expected values in brackets from year one to four. The calculated Chi-square value, x^2 was 20.7331 with a critical value of 6.25.

Considering these values, the hypothesis one was accepted, because the calculated value is greater than the critical or table value. This implied that there is a significant difference in performance among university biology/life science education undergraduates.

H_{A2} was tested using the student *t*-test ratio. The result is shown in Table 4.

Table 3

One × Four Contingency Table

Level/year	1	2	3	4	Total
Performance by no. that proceeded	21 (26)	32 (38)	145 (147)	83 (133)	281 (344)

Notes. The Chi-square formula $X^2 = \sum \underline{(o-e)^2}$; E was applied at a degree of freedom ; *df* = 3 to analyse hypothesis HA1.

Table 4

T-test Result of Male and Female Biology/Life Science Education Students Performances

Variables	*N*	Mean	*SD*	Standard error	*df*	*t*-cal	*t*-critical
Male	102	25.50	31.234	12.376	342	14.73	13.29
Female	242	60.50	12.883				

Table 4 "*N*" as the number students involved in the study, "*SD*" as standard deviation and "*df*" as the degree of freedom and further shows the calculated *t*-value as 14.731 which is greater than the critical *t*-value of 3.291 at a degree of freedom, *df* = 342. This necessitated the acceptance of the H_{A2}. Hence, there is a significant difference between the male and female biology/life science education students' performance. The standard deviations resulting from the analysis show that the determined difference in the favor of the female undergraduates.

Findings and Discussion

The study has found out that significant differential performance exists among undergraduates offering biology/life science education in the universities. It further found out that differential performance in terms of gender attribute is equally prominent. An in-depth view into the performance indicators of the study shows a deviation from the usual differential pattern observed by many previous researchers. As the second finding has proved that the female students performed much better than their male counterparts in biology/life science education. This is in disagreement with Hyde, Linberg, Linn, Ellis, and Williams (2008) who generalized that a slightly greater male variability in scores than females exist in STM (science, technology and mathematics) fields. The present study addressed biology/life science education as one of the science disciplines in which the female students are now on the lead. This may be attributed to the ability and love of the female gender in dealing with real life activities and their love for colorful and aesthetic presentations in their natural states as found in biology and life science.

Moore (2006) noted that most students in introductory biology courses in the first instance believe that their efforts are the most accurate predictor of their academic performances and are confident that they will work hard and earn high grades. He further observed that despite of their optimisms, many students do not follow through on their expectations and their grades drop accordingly. These observations could have been possible through performance analysis. It would imply that a lot of factors surrounding the academic behaviors of the students must have come into play between the time of entry into the course and graduation, having been taught by the same lecturers under the same environment and with the same curriculum. Some of the academic

behaviors include attendance at lectures, attendance at help sessions, submission of extra-credit work and compliance with reading assignment (Moore, 2006). These behaviors appear to be motivation-based, hence the result of the present study showed differential performance levels among the students. The fact that female undergraduate biology/life science education students have performed better than their male counterparts shows that they are greater confident in their predicted level of performance at the entry time into the course. However, the students are expected to take the positive sides of the academic behaviors listed above to match with their confidence level and attainment of their predicted performance.

Anagbogu and Ezeliora (2007) in their study on sex differences and scientific performance in Amabra State, Nigeria found out that girls performed better than boys using strategies that are human-oriented. Biology/life science generally portrays a high level of humanistic attribute which goes a long way to blend with the tender-hearted nature of the females. This could explain or shed some light why the second finding of this study proved a significant differential performance in the favor of female undergraduates of biology education. Closely related to this proof is the report of Jenny (2009) on October 23 in an answer to the question "Is biology a woman's science?". She pointed out that two out of the three Nobel winners for physiology and medicine were women in 2009. In her view, this is a state of affair that seems so astronomically impossible to some commentators that they have speculated that "telomers" must somehow be a "girls" area. The level of astonishment reached in this view is most probably based on the age-long belief that science is generally masculine and offered by men mainly.

This study did not see biology/life science as a cheaper field but that the female students may have performed better than the males because of their level of preparedness from the beginning of the programme. This is in agreement with one of the female laureates of 2009, Carol Greider about "the founder effect". A good foundational preparation and consistent growth in any field makes the concerned individuals to become friendly with the field and hence perform above average in it. This appears to be the case of the female biology/life science education students. However, the expectation is that science including biology should not be gender-biased in contents, contexts and approaches to teaching. Hence, NSTA made an official declaration on how to achieve gender equity cutting across all parts of science education to ensure that all boys and girls achieve scientific literacy. The declarations as adopted by the NSTA board of directors in July 2003 are shown that:

> In the classroom, science teachers must:
>
> (1) Implement varied and effective research-based teaching and assessment strategies that align with the learning styles of all students;
>
> (2) Ensure that all students are in a learning environment that encourages them to participate fully in class discussions and science activities and investigations.
>
> In developing and implementing professional development and teacher preparation programs, science teachers, administrators, teacher educators, and policy makers must:
>
> (1) Ensure that discussions about research-based issues related to the pedagogy of gender equity are an integral part of professional development and teacher education programs;
>
> (2) Be aware of their own deep-seated beliefs so that they can ensure that their beliefs do not interfere with objective science teaching.

In selecting science curriculum, science teachers, administrators, and community members must:

(1) Select only those curriculum materials that promote gender inclusiveness through their text, illustrations and graphics;

(2) Select only those curriculum materials that present culturally diverse male and female role models working in all disciplines and at all levels of science.

In developing assessment tools, science teachers, administrators, and evaluators must:

(1) Design and implement varied kinds of assessment models so that all students, regardless of their learning style, can be assessed fairly in science;

(2) Provide administrative support for the development and use of a range of assessment tools that promote gender equity.

In helping students prepare for careers, guidance counselors and science teachers must:

(1) Encourage all students to consider science and science-related careers by exposing them to a range of school and community activities;

(2) Provide all students with the most recent information about the kinds of opportunities available in the sciences, as well as the preparation necessary to attain such careers.

Some verbal interrogations of a handful of the staff and students of Delta State University, Abraka in Nigeria, University of South Africa, Pretoria and the University of Pretoria by the present researcher showed some links between the living environment of students and their general academic performances. It was observed that students who live closer to and within their campuses (most of whom are girls) perform better than those (more of boys) that live far away from their campuses. This is in agreement with Thombs, Olds, Bondy, Winchell, Baliunas, and Rehm (2009). Thombs et al. (2009) in their study carried out in the United States of America found that living environment may have a great effect on the academic achievement of undergraduates. This observation in the present study may be attributed to such indices as higher noise factor, incessant power failure (as was the case of Abraka within the period of consideration), psychomotor fatigue and exhaustion that usually affect students that live outside the university campuses. Furthermore, Sheard (2009) found out that female students significantly outperformed their male counterparts in each measured academic assessment criteria used in his study and proved that the female students showed more commitment that the males in their studies. This implies that commitment is one of the strong indices that can bring about equality in performance.

Conclusions and Recommendations

In conclusion, this study has shown that a significant difference in academic performance exists among biology/life science education undergraduates. Furthermore, it clearly showed that the female undergraduates show higher performance level than their male counterparts. This result generates a major factor why in a random sample of 22 life science educators from 15 high schools in Gauteng Province, South Africa by the present researcher, 14 of them were females as against eight male educators. The result is in agreement with Keller (2010) who observed that over the past few decades, the wide gap in science performance between male and female students has been considerably reduced. The view to provide equal opportunities to male and female undergraduates studying biology/life science to become qualified science educators is expected to be

propagated. This will ensure that neither male or female students become more advantaged than the other thereby, perpetrating inequality and disadvantaged situations in science education in any part of the world. In view of the above and given the importance of biology/life science to humanity, this paper recommends that:

(1) All biology/life science education curriculum lecturers and planners in the universities and associated institutions in Nigeria, South Africa and the rest of the world should endeavor to make the discipline equally attractive to both male and female students alike. Any trace of gender stereotyping and all other disparities associated with the discipline should be removed to encourage equal opportunity of all. This can be achieved by avoiding bias, having high expectations for all students which tend to increase students' achievement and using non-sensitive classroom strategies by the lecturers, the same non-verbal cues and balanced metaphors to address both boys and girls. It is the belief of this author and in agreement with Clifton, Perry, Roberts, and Peter (2008) that both male and female students can improve their coping strategies and academic controls as these affect their academic achievement directly;

(2) Male students who opt for biology/life science education as a course of study should endeavor to show commensurate commitments as their female counterparts in order to be within the same or close performance range;

(3) Future research may examine gender interest, population-ratio and achievement in biology/life science education.

References

Anagbogu, M. A., & Ezeliora, B. (2007). Sex differences and scientific performance. *Women Journal of Science and Technology, 4,* 10-20.

Aultman, L. P., Williams-Johnson, M. R., & Schutz, P. A. (2009). Boundary dilemmas in teacher-student relationships: Struggling with "the line". *International Journal of Research and Studies, 25*(5), 636-646. Retrieved October 11, 2009, from http://eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=ERICSearchRe

APU (Assessment of Performance Unit). (1989). *National assessment: The APU science approach.* London: HMSO.

How to attain gender equity in science classroom. (2010). Barcodes Inc.. Retrieved September 17, 2010, from http://www.barcodesInc.com/articles/gender_equity~scienceeducation.html

Bennett, J. (2003). Teaching and learning science. In A. Richard, (Ed.), *Continuum studies in research in education* (p. 206). London: Continuum.

Bishop, R., Berryman, M., Cavanagh, T., & Teddy, L. (2009). Te Kotahitanga: Addressing educational disparities facing Maori students in New Zealand. *International Journal of Research and Studies, 25*(5), 734-742. Retrieved October 11, 2009 from http://eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=ERICSearchRe

Carie, A. C. (2009). Evaluating college students' evaluations of a professor's teaching effectiveness across time and instruction mode (online vs. face-to-face) using a multi-level growth modeling approach. *Computer & Education, 53*(2), 429-435. Retrieved October 11, 2009, from http://eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=ERICSearchRe

Clifton, R. A., Perry, R. P., Roberts, L. W., & Peter, T. (2008). Gender, psychosocial dispositions and the academic achievement of college students. *Research in Higher Education, 49*(8), 684-703.

DoE (Department of Education). (2003). *National curriculum statement, grades 10-12 (general)—Life sciences.* Pretoria: Government Printer.

Hyde, J. S., Linberg, S. M., Linn, M. C., Ellis, A. B, & Williams, C. C. (2008). Diversity: Gender similarities characterize mathematics performance. *Science Magazine, 32*(5888), 494-495. Retrieved November 3, 2009, from http://www.sciencemag.org/cgi/content/full/321/5888/494

Jenny. (2009). *Is biology "A women's science".* Retrieved November 18, 2009, from http://blogs.lablit.com/2009/10/is-biology-a-women's-science/

Keller, E. (2010). *Gender equity in science education.* Retrieved September 17, 2010, from http://www.as.wvu.edu/~equity/gender_feedback.html

McGowan, W. R., & Graham, C. R. (2009). Factors contributing to improved teaching performance. *Innovative Higher Education, 34*(3), 161-171. Retrieved October 11, 2009, from http://eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true &_pageLabel=ERICSearchRe

Moore, R. (2006). What uncouples students' goal from students' outcomes in introductory biology courses? *The Science Education Review, 5*(1), 16:1-16:7.

Marginson, S., & van der Wende. (2007). Globalization and high education. *The Organization for Economic Co-operation and Development OECD Education Working Papers, 8.*

NSTA (National Science Teachers Association). (2010). Gender equity in science education—Official positions. Retrieved September 17, 2010, from http://www.nsta.org/about/positions/genderequity.aspx

NUC (National Universities Commission). (2005). *Draft benchmark minimum academic standards for education in Nigerian universities.* Abuja: Government Press.

Ochonogor, E. C. (2006). Gender barriers in science, technology and mathematics education (STME). In E. A. C. Okeke, & M. Opara (Eds.), *JSTAN, Gender and STM Education* (series No. 1, pp. 90-100).

Sheard, M. (2009). Hardiness commitment, gender, and age differentiate university academic performance. *British Journal of Educational Psychology, 79,* 189-204.

Smeenk, S., Teelken, C., Eisinga, R., & Doorewaard. (2009). Managerialism, organizational commitment, and quality of job performance among European university employees. *Research in Higher Education, 50*(6), 589-607. Retrieved October 11, 2009, from http://eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=ERICSearchRe

Thombs, D. L., Olds, R. S., Bondy, S. J., Winchell, J., Baliunas, D., & Rehm, J. (2009). Undergraduates drinking and academic performance: A prospective investigation with objective measures. *Journal of Studies on Alcohol and Drugs, 70*(5), 776-785.

Westbrook, J. O., Shah, N., Durrani, N., Tikly, C., Khan, W., & Dunne, M. (2009). Becoming a teacher: Transitions from training to the classroom in the NWFP, Pakistan. *International Journal of Educational Development, 29*(4), 437-444. Retrieved October 11, 2009, from http://eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=ERICSearchRe