ENHANCING GENDER EQUALITY IN SCIENCE AND TECHNOLOGY EDUCATION: EXTENT OF SCALING-UP FEMALE PARTICIPATION IN PHYSICS EDUCATION

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Abstract

The study sought to determine the mode of dependence of access to NCE Physics education on gender over a 5-year period, covering 2000/2001 – 2004/2005. A sample size of 1175 NCE Physics graduates, lifted from 25 Nigerian Colleges of Education, was subjected to percentage analysis and chi-square test. The percentage representation of females for the 5 years were: 31.0%, 31.2%, 32.2%, 27.4% and 38.0%, respectively. Chi-square test showed that the production of NEC graduates in Physics depended significantly on gender, in favour of male students. Based on the overall arithmetic progression in the paltry, percentage production of female graduates translating to significant dependence of production of NCE Physics graduates on gender, it was inferred that: Nigeria was seriously lagging behind the United Nations Millennium Development Goal of achieving gender equality in educational opportunity at the secondary school level by 2005; Meeting the 2015 deadline for achieving the goal at the tertiary levels of education would be an optical illusion. A productive, constructivist approach to teaching and learning was recommended.

People are born male or female, but learn to be boys and girls who grow up into men and women. They are taught what the appropriate behaviours and attitudes, roles and activities are for them and how they should relate to other people. The learned behaviour is what makes up gender identity and determines gender roles (Nwagu, 2009) which have been, and are still, stereotype.Gender is a socio-cultural construct in which women are systematically subordinate (UNESCO, 2002a). Gender-stereotype refers to a collection of rigidly held beliefs or opinions about what behaviours and characters are appropriate for females and males (Nwosu, 2006). The society arrogates certain roles children should play according to gender. Boys are socialized to be competitive, assertive, aggressive and dominant; while girls are socialized to be docile, submissive, obedient, friendly, cooperative and supportive.

Difficult and challenging tasks are assigned to boys in the society while domestic and easier chores are assigned to

girls. Children seem to carry these sex-role attribute into the school. For instance, physical sciences and technical courses are male dominated while biological sciences, Home Economics and Secretarial Studies are female dominated. Nzewi (2003) attributed the streaming of students in school subjects along gender lines to the reference being made of these subjects as 'hard' and 'soft'. Thus, the arbitrary arrogation of roles by gender has given rise to the masculine image of science and technology.

Achievement of Males Relative to Females in Science and Technology Subjects

Research studies are replete with findings on gender-disparity in Science and Technology education. Ayogu and Nworgu (1999) found a significant gender-difference in students' achievement in Physics in favour of males. Ajunwa (2000) found a significant difference in acquisition of Physics process skills in favour of male students.

Awodeji (1997) found that even at the university level, males performed significantly, better than females in the Ancillary mathematics courses for engineers. However, this difference was not significant between males and females who did Further Mathematics at the secondary school level. In contrast, Anaeka (1997) found no significant difference between males and females in achievement in science due to interaction pattern.

Similarly, Madu (2004) found no significant gender-difference in achievement in science due to the use of constructivist model of teaching. "Intelligence, as an entity, has normal distribution in the population and has shown no gender discrimination. Women, therefore, need no advocates for their intelligence" (Aminu, in Uwadiae, 2006).

From the afore-going, the underachievement of females relative to males in science and technology subjects at school level is not due to any superior mental ability on the part of males. According to Okeke (2000), the under-representation and under-achievement of females in science and technology disciplines are historical and have been brought about by several inter-related socio-cultural and interacting school factors which act singly and jointly to depress female interest, enrolment, participation and achievement in science and technology subjects at various levels of Nigerian Education System.

Gender Barriers in Science and Technology Education

There are several gender-based factors militating against the females' interest in science and technology. The two most critical factors are hereby discussed.

Gender Bias in Science and Technology Curricula

Science and technology textbooks are flushed with sexist language, illustrations, pictures, activities, experiences and achievements that radiate

the masculine gender thus, painting a masculine image for science and technology education and invariably posing a discomfort for the females. Consider the sexist statement, "John is a medical doctor", accompanied with a diagram depicting a man treating a patient in a hospital or clinic, as if Mary cannot be a medical doctor. Incidentally, it is only in such stereotype roles or careers as nursing, catering or secretarial studies is Mary highlighted. Such learning context tends to create barriers against the females.

Teachers' Influence

The psychological effect on girls and women of being alienated from the fields of science and technology is rooted in the society. Science and technology teachers being integral part of the gender-divide society, neither expect nor encourage the females to perform well in these disciplines. "Not only do teachers of science and technology subjects interact more with the boys during classroom discussions, question-and-answer sessions, practical activities, excursion and field trips, they allow the boys to dominate science and technology activities by overtly expressing more confidence in them" (Njoku, 2006). In coeducational schools, girls tend to be interrupted more frequently by teachers than boys; when this happens, the girls get the impression that their contributions are not valuable and they hesitate to join in class discussion in future (Opera, 2006). These gender barriers are totally unacceptable. The women who have been and who are still the traditional educators, environmentalists, nutritionists, and health workers must come to the forefront and bring to bear their traditional strengths, accumulated knowledge, wisdom and roles upon the future direction of national and international science (UNESCO, 2000 cited in Nwosu, 2006).

Enhancing Gender Equality

Gender equality entails the concept that all human beings, both men and women, are free to develop their personal skills and make choices without limitations set by stereotypes, rigid gender roles and prejudices. Equality between men and women means that the different behaviours, aspirations and needs of women and men are considered, valued and favoured equally. It does not mean that women and men have to become the same, but that their rights, responsibilities and opportunities will not depend on whether they are born male or female (UNESCO, 2002b) Several measures/strategies have been recommended to enhance equality in educational opportunities of males and females with a view to scaling-up the participation of the girl child in science and technology education.

These measures/strategies include

1. Sensitizing science and technology teachers about gender issues in science and technology education.
2. De-sexing science and technology curriculum materials.
3. Applying gender-sensitive teaching approaches.
4. Increasing women membership in policy-making.

Sensitizing Science and Technology Teachers

Most teachers are ignorant of the effect of gender-stereotyping which they practice/encourage in the classroom because they themselves are products of the gender-divide society. To remove this ignorance, science and technology teacher education should incorporate classroom strategies involving gender-fair sensitization of trainee teachers. These teachers should be sensitized on the need for gender-fairness in their instructional behaviours. They should have equal expectation for all students, regardless of gender.

De-sexing Science and Technology Curriculum Materials

Science and technology curriculum materials have been and are still gender-biased in favour of male learners. De-sexing these materials refers to the removal of these gender-biases, including the simultaneous establishment of gender-sensitivity by ensuring gender-balancing of language, illustrative diagrams, figures, pictures, models, activities and presentation of role-models. It refers to the use of impersonal pronouns and non-sexist language such as 'human power' rather than 'man power'; 'humanity' in place of 'men' or 'women'. It is gender-balancing/inclusive, if for instance, the frequency of illustrating a medical doctor or an engineer in textbooks using pictures is the same or nearly the same for a man as for a woman.

Applying Gender-Sensitive Teaching Approaches

To promote gender-sensitivity, the first step is for the teachers to demonstrate that every learner in the classroom is equally important and can perform well. This can be achieved through a democratic, gender-fair, classroom climate that guarantees unbiased freedom to air out views, ask and answer questions.

In his instructional process, a teacher should use gender-free/fair language such as balancing the frequency of the use of the pronouns "he" and "she". The use of masculine pronouns e.g. "he" should not dominate/over-shadow the use of feminine pronoun e.g. "she". Along gender-fair line of reasoning, group project is considered a 2-way, trustworthy, communication vehicle for sharing knowledge between the male and female students. It is therefore recommended. Ideally what is required is constructivism implementation.

In a constructivist classroom, the climate is cooperative, environment is democratic, the activities are interactive and student-centered; the students are empowered by their teacher who operates as a facilitator/consultant. In such a gender-fair environment, domination is absent; reciprocity, cooperation and collaborative involvement are prominent. Learning emerges as a process of constructing, creating, inventing and developing knowledge.

Increasing Women Membership in Policy-Making

Increasing the participation of women policy-making will ensure that decision on breaking gender-barriers to girls education is implemented. This would translate to a significant increase in girls participation in science and technology education. But has this actually been the case?

The Problem

Sex-role stereotype is the major reason why we have few engineers, doctors and technologists. This is a global issue that cannot be allowed to go unchecked. This is why the United Nation's third Millennium Development Goal (MDG) has as it's aim the elimination of gender-stereotyping which underlines gender-disparity in education at all levels. Specifically it aims at eliminating gender-disparity in primary and secondary education, preferably by 2005, and at all levels by 2015. Accordingly in the spirit of the MDG, the afore-listed strategies/measures to eliminate the stereotype to ensure gender equality and equity, have been adopted. What remains is the evaluation of the extent or realization of the MDG.

Now, let's reflect on gender imbalance in the teaching of Physics. The Federal Republic of Nigeria recognizes the place of Physics as a major pre-requisite for the study of engineering, technology, medicine and pharmacy. Therefore, in seeking to eliminate gender-stereotype, as many female teachers as the male counterparts should be found in the physics classroom. That should be a good starting point in the context of meeting the MDG.

The Federal Republic of Nigeria stipulates that the National Certificate in Education (NCE) shall be the minimum qualification for teachers in the country (NTI, 2000). The male-female pattern of graduation in Physics education at NCE level over a period of five years will give a good measure of access to senior secondary Physics education due to gender over the said period. The objectives of this study therefore are:

(i) To determine the mode of dependence of access to senior secondary physics education on gender for a 5-year period, covering 2000/2001 – 2004/2005, inferred from data analysis involving NCE graduates in physics.

(ii) To extrapolate from the current trend, the extent of meeting the UN goal of achieving gender-balance in educational opportunity at the tertiary levels of education by 2015. Overall, the aim of this study is to determine the extent of scaling-up females' participation in physics education, over a period of five years.

Data Analysis

Ogunneye and Lasisi (2008) conducted a simple survey to investigate

Table 1: Production Profile of NCE Physics Teachers by 25 Nigerian Colleges of Education

S/N	2000/2001		2001/2002		2002/2003		2003/2004		2004/2005	
	M	F	M	F	M	F	M	F	M	F
1.	-	6	1	5	3	5	3	5	7	16
2.	6	0	8	2	5	1	6	1	-	-
3.	-	-	-	-	-	1	3	1	-	-
4.	4	1	4	1	4	3	7	0	5	5
5.	12	-	8	-	1	-	16	1	2	2
6.	2	-	-	-	2	-	4	-	5	5
7.	-	9	3	6	-	6	-	1	10	10
8.	7	10	6	13	5	10	7	13	-	-
9.	-	-	-	-	3	1	2	2	-	-
10.	1	1	1	-	1	-	3	-	13	-
11.	1	-	1	-	2	-	16	10	16	12
12.	-	-	-	-	3	2	8	0	16	5
13.	3	2	10	5	-	-	7	4	5	3
14.	-	-	12	3	5	2	5	2	14	0
15.	-	-	0	0	5	0	5	2	5	2
16.	3	-	1	-	4	-	14	4	30	12
17.	5	1	3	-	-	1	6	2	-	-
18.	28	12	17	6	22	8	19	9	26	18
19.	9	-	4	0	5	0	11	2	9	3
20.	-	-	-	-	-	-	2	1	1	3
21.	6	-	8	1	11	1	9	-	10	-
22.	-	-	2	-	3	-	4	-	12	1
23.	1	1	3	-	3	-	6	-	1	-
24.	3	2	-	1	3	3	4	3	2	1
25.	9	-	15	6	11	4	74	28	54	51
Total	100	45	108	49	101	48	241	91	243	149
Total	145		157		149		332		392	

Source: Ogunneye and Lasisi (2008).

Now, let's subject Table 1 to chi-square analysis of the production of NCE Physics graduates based on gender.

Table 2: Chi-square Analysis of Dependence of Production of NCE Physics Graduates on Gender.

S/N	2000/2001		2001/2002		2002/2003		2003/2004		2004/2005	
	M	F	M	F	M	F	M	F	M	F
1.	0.00	6.00	1.00	5.00	3.00	5.00	3.00	5.00	7.00	16.00
	(4.14)	(1.90)	(4.10)	(1.90)	(5.40)	(2.60)	(5.80)	(2.20)	(14.30)	(8.70)
2.	6.00	0.00	8.00	2.00	5.00	1.00	6.00	1.00	0.00	0.00
	(4.14)	(1.90)	(6.80)	(3.20)	(4.10)	(1.90)	(5.10)	(1.10)	(0.00)	(0.00)
3.	0.00	0.00	0.00	0.00	0.00	1.00	3.00	1.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.68)	(0.32)	(2.90)	(1.10)	(0.00)	(0.00)
4.	4.00	1.00	4.00	1.00	4.00	3.00	7.00	0.00	5.00	5.00
	(3.40)	(1.60)	(3.4)	(1.60)	(4.70)	(2.30)	(5.10)	(1.90)	(6.20)	(3.80)
5.	12.00	0.00	8.00	0.00	1.00	0.0	16.00	1.00	2.00	2.00
	8.30)	(3.70)	(5.50)	(2.50)	(0.68)	(0.32)	(12.30)	(4.70)	(2.50)	(1.50)
6.	2.00	0.00	1.00	0.00	2.00	0.00	4.00	0.00	5.00	5.00
	(1.40)	(1.62)	(0.68)	(0.32)	(1.40)	(0.64)	(2.90)	(1.10)	(6.20)	(3.80)
7.	0.00	9.00	3.00	6.00	0.00	6.00	0.00	1.00	10.00	10.00
	(6.20)	(2.80)	(6.20)	(2.80)	(4.10)	(1.90)	(0.73)	(0.27)	(12.40)	(7.60)
8.	7.00	10.00	6.00	13.00	5.00	10.00	7.00	13.00	0.00	0.00
	(11.70)	(5.30)	(13.0)	(6.00)	(10.20)	(4.80)	(14.50)	(5.50)	(0.00)	(0.00)
9.	0.00	0.00	0.00	0.00	3.00	1.00	2.00	2.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(2.70)	(1.30)	(2.90)	(1.10)	(0.00)	(0.00)
10.	1.00	1.00	1.00	0.00	1.00	0.00	3.00	0.00	13.00	0.00
	(1.40)	(0.62)	(0.68)	(0.32)	(0.68)	(0.32)	(2.20)	(0.82)	(8.10)	(4.90)
11.	1.00	0.00	1.00	0.00	2.00	0.00	16.00	10.00	16.00	12.00
	(0.69)	(0.31)	(0.68)	(0.32)	(1.40)	(0.64)	(18.9)	(7.20)	(17.40)	(10.60)
12.	0.00	0.00	0.00	0.00	3.00	2.00	8.00	0.00	16.00	5.00
	(0.00)	(0.00)	(0.00)	(0.00)	(3.40)	(1.60)	(5.80)	(2.20)	(13.00)	(8.00)
13.	3.00	2.00	10.00	5.00	0.00	0.00	7.00	4.00	5.00	3.00
	(3.40)	(1.60)	(10.20)	(4.70)	(0.00)	(0.00)	(8.00)	(3.00)	(5.00)	(3.00)
14.	0.00	0.00	12.00	3.00	5.00	2.00	5.00	2.00	14.00	0.00
	(0.00)	(0.00)	(10.20)	(4.70)	(4.70)	(2.30)	(5.10)	(1.90)	(8.700)	(5.300)
15.	0.00	0.00	0.00	0.00	5.00	0.00	5.00	2.00	5.00	2.00
	(0.00)	(0.00)	(0.00)	(0.00)	(3.50)	(1.60)	(5.10)	(1.90)	(4.30)	(2.70)
16.	3.00	0.00	1.00	0.00	4.00	0.00	14.00	4.00	30.00	12.00
	(2.10)	(0.93)	(0.68)	(0.32)	(2.70)	(1.30)	(13.10)	(4.90)	(26.00)	(16.00)
17.	5.00	1.00	3.00	0.00	0.00	1.00	6.00	2.00	0.00	0.00
	(4.10)	(1.90)	(2.10)	(0.94)	(0.68)	(0.32)	(5.80)	(2.20)	(0.00)	(0.00)
18.	28.00	12.00	17.00	6.00	22.00	8.00	19.00	9.00	26.00	18.00
	(27.60)	(12.40)	(2.10)	(7.30)	(20.30)	(9.70)	(20.30)	(7.70)	(27.20)	(16.70)
19.	9.00	0.00	4.00	0.00	5.00	0.00	11.00	2.00	9.00	3.00
	(6.20)	(2.70)	(15.70)	(1.30)	(3.40)	(1.60)	(9.40)	(3.60)	(7.40)	(4.60)
20.	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	1.00	3.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(2.20)	(6.82)	(2.50)	(1.50)
21.	6.00	0.00	8.00	1.00	11.00	1.00	9.00	0.00	10.00	0.00
	(4.10)	(1.90)	(6.20)	(2.80)	(8.10)	(3.90)	(6.50)	(2.50)	(6.20)	(3.80)
22.	0.00	0.00	2.00	0.00	3.00	0.00	4.00	0.00	12.00	1.00
	(0.00)	(0.00)	(2.10)	(0.62)	(2.00)	(0.97)	(2.90)	(1.10)	(8.10)	(4.90)
23.	1.00	1.00	3.00	0.00	3.00	0.00	6.00	0.00	1.00	0.00
	(1.40)	(0.62)	(2.10)	(0.94)	(2.00)	(0.97)	(4.40)	(1.60)	(0.62)	(0.38)
24.	3.00	2.00	0.00	1.00	3.00	3.00	4.00	3.00	2.00	1.00
	(3.50)	(1.60)	(0.68)	(0.32)	(4.10)	(1.90)	(5.10)	(1.90)	(1.90)	(1.10)
25.	9.00	0.00	15.00	6.00	11.00	4.00	74.00	28.00	54.00	51.00
	(6.20)	(2.90)	(14.40)	(6.60)	(10.20)	(4.80)	(74.00)	(28.00)	(65.10)	(39.90)
	$X^2 = 65.37$		$X^2 = 153.32$		$X^2 = 46.45$		$X^2 = 46.46$		$X^2 = 52.36$	
	(38.88)		(36.42)		(36.42)		(36.42)		(36.42)	

Frequency values in brackets are expected values. X^2–values in brackets are critical values. $P<0.05$; df = 24.

Table 1 Reveals that

1. For the period 2000/2001, a total of 145 NCE Physics graduates were produced. Out of this number, 45 were females, representing 31.0% of the total.

2. For the period 2001/2002, a total of 157 NCE Physics graduates were produced, out of which were 49 females, representing 31.2% of the total.

3. For the period 2002/2003, a total of 149 NCE Physics graduates were produced, out of which were 48 females, representing 32.2% of the total.

4. For the period 2003/2004, a total of 332 NCE Physics graduates were produced, out of which were 91 females, representing 27.4% of the total.

5. For the period 2004/2005, a total of 392 NCE Physics graduates were produced, out of which were 149 females, representing 38.0% of the total. Table 2 revealed that for the

6. period of 5 years (2000/2001-2004/2005), the production of NCE graduates in physics depends significantly on gender, in favour of males since the calculated x^2-values for the 5 years (x^2 = 46.46, 52.36, 38.88, 153.22 and 46.45) were respectively, greater than the critical X^2-value (36.42) at 44 degrees of freedom and 0.45 level of significance.Assembling the calculated percentage values for the female NCE graduates to look for trend, we have: 31.0%, 31.2% 32.2%, 27.4% and 38.0%. Clearly, except for the 2003/2004 school year in which we witnessed a set back from 32.2% representation of women to 27.4%), an arithmetical progression in female representation was being observed which translated to a gradual motion towards gender equality in educational opportunity at this level. The unpleasant revelation is that we have seriously lagged behind the UN MDG at the secondary school level. The attendance implication is that not much progress was being made in terms of adopting the advocated strategies for breaking gender-impediments.

Summary/Conclusion

Gender-stereotyping lies at the root of females' under-representation and under-achievement in science and technology. Recognizing the colossal negative effect on humanity, the United Nation, as a matter of exigency sets 2005 as a deadline for elimination of gender-stereotyping/barrier at the secondary school level, through several recommended strategies such as having equal expectations for all students by teachers/society and using gender-free

languages in a democratic instructional process.

Research findings revealed that from a paltry value of 31.0% in 2000/2001, the production of NCE physics graduates slowly reached an unimpressive value of 38.0% in 2004/2005 school year but not/without dwindling in 2003/2004 school year.

The unimpressive value (38.0%) as at 2005 implies that females participation in Physics education has been minimally scaled up. It indicates that the use of the recommended strategies is still in its embryonic stage; the arithmetic progression in the rate of overcoming gender-stereotyping implies that removing gender-imbalance in educational opportunity at the secondary school level by 2015, a target set for tertiary levels of education would be an optical illusion.

Recommendation

Based on the critical analysis of the issue, the following recommendation is made. Besides a mandatory adoption of productive constructivist approach to teaching and learning, regular interclass debates/competitions on gender issues should receive attention, by way of cash prizes and trophies, from the local, state and federal governments. The objective of these school debates/competitions should be to narrow down or eradicate the gender-gap between males and females in science and technology education in general, physics education in particular.

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