Breaking Barriers to Girls' Achievement in Senior Secondary Physics by Combating Gender-Stereotype with Inductive Instructional Approaches

By

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Abstract

The study investigated the efficacy of inductive instructional approach, relative to the deductive method, in breaking gender-stereotype, to enhance improved performance of female students in senior secondary Physics. Purposive sampling technique was used to draw a sample size of 280 Physics students (185 males, 95 females) in six intact classes from six schools in Abak Educational Zone of Akwa Ibom State. Instructional Package for senior secondary-three Physics (IPSS3P) and Essay-type Physics Achievement Test (EPAT) were used to gather data for the study. The data obtained was analyzed using independent t-test statistics. Post test analysis of data showed a significant difference in achievement in senior secondary Physics between male and female students exposed to deductive method, in favour of boys; the significance difference vanished when male and female students were exposed to the gender-sensitive, inductive approach to teaching. Ego-motivated, gender-balanced, inductive instructional approaches such as the guided-discovery approach, capable of breaking school-based gender-stereotypes were, therefore, recommended for implementing senior secondary Physics curriculum.

Gender-disparity in educational opportunity and achievement averred to be anchored by gender-stereotyping has been a global issues since the genesis of formal education. Incidentally, this phenomenon has persisted, undermining developmental efforts, signaling a serious threat to global economy. Accordingly, this subject has become a matter of growing concern to the United Nations, warranting adequate clarification of two key terms-gender and gender-stereotyping to keep the issue in perspective.

Gender is a socio-cultural construct in which women are systematically subordinate (UNESCO, 2002). Gender-stereotyping is the socio-cultural classification

of human activities and attributes by gender in line with what the society considers appropriate for males and females. Gender plays a significant role in the socialization process, in the families, communities, the media, law and policy formulation. Gender stereotype limits how girls and boys, women and men live their daily lives. Roles of mothers/wives, father/husbands, occupational choice, household tasks, indoor and outdoor activities are also gendered.

The stereotypical ways of being men and women perpetuate the ideas that men are strong, violent, domineering, aggressive, etcetera; and that women are feable, submissive, compassionate, tolerant and nurturing. Accordingly, boys are depicted as action-oriented, adventurous and problem-solvers in outdoor settings. The girls, on the other hand, are shown as quiet, nurturers and helpful observers, in indoor settings.

This societal, home-based stereotype has, historically and practically, translated into alienation of females from science and technology education which is, stereotypically, masculine-gendered.

School-Based Obstacles to Gender-Equality in Science and Technology Education

Besides home and social conditioning variables, biological and school factors have been identified (Nkpa, 1999) as underlying obstacles to gender equality in science and technology education. But the influence of biological factor has been debunked by a minister of Education, Prof. Aminu, in Uwadiae (2006). Hear him: "Intelligence, as an entity, has normal distribution in the population and has shown no gender-discrimination. Women, therefore, need no advocates for their intelligence". In support of this, Duramola, in Adeyegbe et al (1997) asserted that gifted girls do not differ from gifted boys in achievement, motivation and other cognitive tasks.

The School Factors

Several school environmental factors have been identified as militating against gender equality in science and technology education. These include: unequitable distribution of infrastructure, sexist content and context of curriculum materials and teachers influence.

Unequitable Distribution of Infrastructure

Disparities have been observed in the provision of science-based infrastructure to boys' and girls' schools. Ventura (1992) reported that even in Malta where Physics is now compulsory for boys and girls, only boys' schools were furnished with technological crafts and graphical communication. In contrast, Home Economics and needle craft were available only in girls' schools.

The Sexist Content and Context of Curriculum Materials

One outstanding aspect of gender-bias in science and technology education is the predominance of males in science textbooks, both as objects of study and illustrations, besides the male sexist language of textbooks. Consider a reader with the line: "Joseph is a medical doctor", accompanied with the diagram of a man wearing a stethoscope (as if a woman cannot wear a stethoscope, let alone Mary becoming a medical doctor). Imagine a learning context in which males alone are shown in the text as engineers. Naturally, a scenario where the contents of science and technology, interms of language, illustrative pictures/diagrams and activities are skewed towards male interest and preferences, is very unlikely to enhance female confidence, interest, participation and achievement in science and technology subjects. In support of this, Fleer (1990) remarked that such learning context reinforce gender-division, which transform technological activities into masculine activities with the female as passive observers.

Teachers Influence

Due to the stereotyped notion that science and technology subjects are appropriate for males only, teachers of science and technology subjects neither expect the females to perform well in these subjects nor encourage them to improve, especially in the physical sciences. Studies show that in the classroom situations, the girls tend to be interrupted more frequently than the boys as if their (girls) contributions were not valuable.

Heidy, Walter, Hilk and Rennate (1986) alleged that science and technology teachers discriminate against the females. According to them, not only do science and technology teachers interact more with the boys during classroom discussion, question-and-answer session, practical activities, etcetera, they allow the boys to dominate science and technology activities by overtly expressing more confidence in them**.**

Combating Gender-Stereotype

To combat gender-stereotype, Nwosu (2006:46) advocated a number of strategies, viz:

(i) Eliminating all forms of gender stereotype at home, society and in schools.

(ii) Bringing in more women in policy-making bodies so as to ensure that Government decision on breaking gender-barriers are carried out.

(iii) Training and encouraging career counselors, especially in schools to promote gender equity in science and technology.

(iv) Developing gender-inclusive, girl-friendly curriculum content, using approaches and practices in schools which will increase girls' interest, motivation and participation in science and technology.

Teacher's Role Will Therefore Include

- The creation of a conducive democratic classroom environment that will enable all students especially the girls to freely air their views, ask and answer questions, and relate positive with the teacher and classmates.
- The use of activity-oriented, inquiry-based, learner-centered, girl-friendly instructional approaches. Such methods may include the use of inquiry/ problem-solving approaches. Teachers roles, as refined/ recommended, will demand a faithful implementation of inductive approach to teaching which appears to be what is needed to stamp-out gender-barriers in science and technology education. This apparent need, is therefore, gaining attention of educational researchers.

Breaking Barriers to Girls' Achievement in Senior Secondary Physics by using Inductive teaching Method

Inductive teaching and learning is an umbrella term that encompass a range of instructional methods such as inquiry, guided-discovery and problem-based teaching methods. A teacher will be competent to the extent that he employs the most appropriate teaching method(s). To implement the senior secondary Physics curriculum, the federal ministry of education recommends the more inductive-based guided-discovery method (Obioma, 2009) rather than the more deductive, traditional lecture-based teaching method.

The Lecture Method

The lecture method involves a one-way flow of information from the teacher to the students (NTI, 2007). It involves verbal presentation of ideas, concepts, generalizations and facts. The teacher does most of the work by talking while students are just passive or slightly involved by taking down notes and asking a few or no questions. It cannot meet the different needs of the students as regards individual differences. The desired learning outcomes may not be accomplished (Aina, 2006). This method is not effective in the teaching of science and technology (NTI, 2007).

The Guided-Discovery Method

The guided-discovery method is a learner-centered instructional approach which imposes more responsibility on the students for their learning than the lecture method does. It (guided-discovery) almost always involves students discussing questions and solving problems in class (active learning), with much of the work in and out of class being done by students working in groups (collaborative or cooperative or team-based learning) (Prince & Felder, 2006). The teacher provides the required democratic and conducive classroom environment or atmosphere that can engender learning and high performance in science and technology by boys as well as girls (Nwosu, 2006).

Inductive Method

This is a way of thinking involving reasoning from particular cases to general conclusions. In other word, the method proceeds from the specific to the general and relies on the evidence of the senses (Nwana, 2000). The procedure of using the method involves, according to Onwukam (2000);

- formulating a topic
- collecting and analyzing data
- testing the hypothesis
- formulating a conclusion
- testing the conclusion against new data and analysis
- formulating generalizations.

Deductive Method

The deductive method of reasoning, unlike the inductive method, starts with a generalization which then leads to a specific conclusion (Nwana, 2000). The procedure is as follows (Onwuka, 2000).

- Generalization is given
- Generalization is applied in a new solution and against new data
- conclusion is drawn.

So, now, we have two ways of reasoning inductive and deductive. But which one of these is, empirically, more efficacious in eradicating gender-barrier in physics education is an area of research that is still a void.

The Problem

In order to achieve the objectives of Physics education at the senior secondary school level, Obioma (2009) recommended the guided-discovery method of teaching, strongly encouraging the employment of the student activity-based and inquiry-oriented mode of teaching. As a strategy for breaking of barriers to girls participation, and achievement in, science and technology education, Nwosu (2006) advocate the use of activity-oriented, inquiry-based, learner-centered, girl-friendly instructional approaches, such as the use of inquiry, and problem-solving, approaches, which involve hands-on, minds-on activities by the students. Supporting this advocacy, Madumere (2006) posited that the use of sensitive teaching methods can promote gender-equity. This suggested solution to gender-disparity is interest-evoking. Nevertheless, the research study sought to more from the level of theoretically-suggested solution to the level of empirically proven solution. Specifically, the problem of this study was to investigate the efficacy of inductive instructional approach, relative to the deductive method, in breaking gender-stereotype, and by extension, significantly improve the performance of female students in senior school Physics.

The Coconut

Gender-stereotype is the root of gender-disparity in Physics education, infavour of males. In this research study, therefore, differences in achievement in senior secondary Physics was attributed to gender-stereotype, not gender which appeared as the dependent variable. Afterall, "intelligence as an entity has normal distribution in the population of humans and has shown no gender-discrimination" (Aminu, in Uwadiae, 2006).

The Purpose of the Study

The purpose of the study was to investigate the efficacy of inductive-based, guided-discovery teaching method in breaking barriers to girl's achievement in senior secondary Physics, relative to the deductive-based, lecture method of instruction. Specifically, the objectives of the study were to

(i) determine how boys and girls differ in their performance in senior secondary Physics when exposed to deductive (lecture) method.

(ii) determine how boys and girls differ in their performance in senior secondary Physics when exposed to inductive (guided-discovery) method.

Research Hypothesis

To guide the research study, the following null hypotheses were formulated and tested: there is no significant difference in performance in senior secondary Physics between boys and girls exposed to gender-insensitive.

(i) deductive (lecture) method

(ii) gender-sensitive inductive (guided-discovery) method.

Methodology

The research design adopted for the study was experimental design. The population of the study consisted of all the senior secondary-three (SS3) Physics students in Abak Education Zone (comprising Abak, Etim Ekpo and Ikot Abasi Local Government Areas) of Akwa Ibom State.

Purposive sampling technique was used to draw a sample size of two hundred and eighty (280) Physics students in six intact classes from six schools, the intact classes labeled A, B, C, D, E, F being of size:

A = 50 (38 males M, 12 females F) B = 50 (30M, 12F)
C = 40 (30M, 10F) D = 50 (31M, 19F)
E = 40 (24M, 16F) F = 50 (32M, 18F).

Previously, a survey of secondary schools in Abak Education Zone was conducted to identify co-educational institutions, in urban areas, that have

(i) Well equipped Physics laboratories

(ii) SS3 Physics students in intact classes of size of at least 40
(iii) Qualified Physics teachers (holders of B. Sc, at least)
(iv) Experienced teachers (with a minimum teaching experience of 2 years.

The choice of school in urban areas was informed by the need to control for extraneous variables such as the effects of school location and parental socio-economic status.

Research Instrument

The instruments used to gather data for the study were:
(i) Instructional Package for Senior Secondary-three Physics (IPSS3P)
(ii) Essay-type Achievement Test (EPAT).

Two kinds of IPSS3P were used, viz: $IPSS3P_1$, and $IPSS3P_2$, which contained lesson notes which involved the used of deductive (lecture) and inductive (guided-discover) methods, respectively. The learning materials (topics) in the IPSS3P were drawn from the first term scheme of work for SS3, based on the Federal Ministry of Education Senior Secondary Physics Curriculum (NERDC, 2009).

The topics were:
(i) Series and parallel arrangement of cells/resistors
(ii) Principle of potentiometer (meter bridge and Wheatstone bridge)
(iii) Measurement of: electric current, potential difference, resistance, and e.m.f of a cell, including verification of ohm's law.

The EPAT and IPSS3P were constructed by the researcher, They were face-validated by a panel of two experts in the Department of Science Education of the University of Uyo. The reliability of the EPAT, determined using the coefficient alpha method, was 0.80.

Treatment

The six intact classes under investigation were protested and then randomly assigned to teaching methods to obtain

Deductive (lecture) method:	Groups B, C, D	(control group)
Inductive (guided-discovery) method:	Groups A, E. F	(experimental group)

Supervised by the researcher, the six groups of students were taught by six research assistants, respectively. The researcher assistants were actually the permanent Physics teachers of the respective schools, who were previously given a brief orientation by the researcher (sensitizing them) on the use of appropriate teaching methods and condition for administration of the EPAT. The treatment

(teaching) lasted four weeks. The six groups of students were post-tested on the EPAT.

Data Analysis and Results

The data obtained was analyzed using independent t-test analysis. The result of data analysis were as shown below.

Table 1: t-test Analysis of Difference in Physics Achievement of Male and Female Students Exposed to Gender-insensitive Deductive (lecture) Method.

Test	Variables	N	$\bar{X}$	SD	T	df	Decision at P<.05
Pretest	Physics achievement of boys	91	15.5	3.0	0.84 (1.96	138	NS
	Physics achievement of girls	49	15.1	2.5			
Post test	Physics achievement of boys exposed to deductive method	91	59.0	2.2	11.4 (1.96)	138	S
	Physics achievement of girls exposed to deductive method	49	54.0	2.6			

Ns = Not significant; S = Significant; t-value in bracket is critical value.

Table 1 shows that, in the pretest, the calculated t-value, 0.84, is less than the critical t-value, 1.96, at 0.05 level of significance. This shows that there was no significant difference in performance of the two groups of students during the pretest. This implies that the experimental and the control groups were at the same cognitive level during the pretest.

In the post-test, the calculated t-value, 11.4, is greater than the critical t-value, 1.96 at 0.05 level of significance. This implies that the experimental group of students were significantly superior to the control group, in their achievement in senior secondary physics, due to exposure to deductive method of teaching.

Table 2: t-test Analysis of Difference in Physics Achievement of Male and Female Students Exposed to Gender-sensitive Inductive (guided-discovery) Method.

Test	Variables	N	$\overline{X}$	SD	T	df	Decision at P<.05
Pretest	Physics achievement of boys	94	16.0	2.8	1.30 (1.96)	138	NS
	Physics achievement of girls	46	15.3	3.1			
Post test	Physics achievement of boys exposed to inductive method	94	60.0	2.6	1.80 (1.96)	138	NS
	Physics achievement of girls exposed to inductive method	46	59.2	2.4			

Ns = Not significant; S = Significant; t-value in bracket is critical value.

In table 2, in the pretest, the calculated t-value, 1.30, is less than the critical t-value, 1.96, at 0.05 level of significance. This implies that there was no significant difference in performance of the two groups of students during the pretest. Further, this implies that the experimental and the control groups were of the same entry behaviour during the pretest.

In the post-test, the calculated t-value, 1.80, is less than the critical t-value, 1.96, at 0.05 level of significance. This implies that there was no significant difference between the experimental and control groups of students, in their achievement in senior secondary physics, due to exposure to inductive method of teaching.

Discussion of Findings

The result of t-test analysis of post-test data shows that there is significant difference in achievement in senior secondary Physics between male and female students exposed to deductive (lecture) method, in favour of males (Table 1). The significant difference vanishes when male and female students are exposed to inductive (guided discovery) method (Table 2). Several research findings collaborate to lend credence to the research findings in Table 1 and 2. For instance, Umuhuarbi and Eromosele (2006) found no significant difference in comprehending problems

associated with senior secondary Physics concepts (viz: Archimedes principle, pressure and elasticity) between male and female students when taught by inquiry method. Umuhuarbi and Eromosele's (2006) finding is consistent with that of Ajewole (1990) who found no significant difference in the transfer of learning between male and female students exposed to guided-discovery method.

James and Awodi's (1997) research study provided elaborate revelation. Using the raw scores of pre and post test in senior secondary Biology, they (James and Awodi, 1997) found that; female high achievers in inquiry group perform better than male high achievers in the same group: female high achievers in inquiry group performed better than male high achievers in the lecture group; female high achievers in the inquiry group performed better than female low achievers in the lecture group. Illuminating these research findings, Ochonogor (2006) claimed that the use of materials and instructions that are gender-free in the teaching and evaluation processes is a practical way of removing gender barrier in science, technology and mathematics education. Thus, "the use of sensitive teaching methods can promote gender-equity" (Madumere, 2006).

Conclusion, Implication and Recommendations

Inductive (guided-discovery) method of teaching, relative to the deductive (lecture method) is ego-motivated and gender-sensitive, breaking the most critical barrier to girls achievement in senior secondary Physics, namely, the stereotyped masculine image of Physics.

Hands-on, minds-on, students-activity-based guided-discovery method of teaching is very efficacious in teaching/learning of Physics concepts, regardless of gender, and should therefore be used to implement senior secondary Physics curriculum. But productive implementation of guided-discover approach to teaching demands that classroom discussion, question-and-answer sessions practical activities should be gender-free, in addition to availability of gender-fair career counseling services to students. Accordingly;

- Physics teachers should provide ample opportunity for group discussion of experimental results to engage students in a reciprocal exchange of understanding/knowledge inorder to stimulate and sustain interest, aspiration and self-confident; and reinforce disposition to study Physics, irrespective of gender.
- The school counsellors' professional duty of assisting students make career-choice involving Physics-related disciplines should be based on students' potential, not gender.

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