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School Locatıon and Gender as Factors in Senıor Secondary School Students' Conceptual Understandıng of Force And Motıon

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ABSTRACT

This study which adopted the ex-post facto research design, investigated the influence of gender and school location on students' conceptual understanding of force and motion. It was hypothesized that the main and interaction effects of gender and location on Nigerian senior secondary school students' conceptual understanding of force and motion will not be significant (p<0.05). A sample of two hundred and twenty five (225) senior secondary two physics students was used for the study. The data were collected using the 'Force and Motion Concept Test' (FMCT). Two-way analysis of variance (ANOVA) was used to analyze the data. The result indicated that gender and the interaction of gender and school location were significant (p<0.05) factors in students' conceptual understanding of force and motion. Although female students tended to be superior to their male counterparts in developing conceptual understanding of force and motion, this relative superiority was not consistent across school location. It was therefore recommended that physics teachers should be more gender-sensitive in their pedagogical approaches as well as in the planning of the physics curriculum.

Key Words: *physics achievement, conceptual understanding, force, motion, gender, school location, interaction effect, ex post factor*

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INTRODUCTION

It is of obvious fact that the study of physics cannot be effectively carried out without an empirical analysis of some of the factors that do impede the study of the subject. According to Akinyele (2011), the academic achievement of students in secondary schools has been a subject of concern to many people including parents, administrators, educators, psychologists and counsellors. The poor achievement of students in science especially physics has continued to be a major concern to all and particularly those in the main stream of science education (Ariyo 2006). Eryilmaz (2004) observed that gender contributes to poor achievement of students in physics. Gender according to Yang (2010) refers to the social attributes and opportunities associated with being male and female and the relationships between women and men; girls and boys, as well as the relations between women and those between men. These attributes, opportunities and relationships are socially constructed and are learned through socialization processes. According to Mbajiorgu (2003), female enrolment in physics and science subjects in general is very poor. This is in line with the study by Gonzuk and Chargok (2001) which revealed that the number of females who study physics in secondary and tertiary institutions is small compared to the number of boys. This difference in the number of females and males in the study of physics has created gender disparity in the academic achievement of students in physics and science subjects as a whole.

Gender difference was first investigated by sociologist of education. The focus was largely on female under achievement at every level of the educational system. Therefore there is need to promote the teaching and learning of physics in schools especially among female student. Ajejalami and Busari (1990) identified the following factors as contributing to under representation of females in science and technology education in Africa;

- Lack of functional guidance and counseling services
- Relationship of sex to occupational prestige

- Influence of schooling
- Family background
- Interest among other factors
- Lack of adequate orientation programme
- Societal discrimination against females in education
- Occupational choice and adaptation of science and technology.

Fakorede (1999), in his own contribution posited that poor enrolment of girls in science subjects is due to:

- Inadequate opportunity for girls to study science,
- Inadequate achievement of girls in science,
- Inadequate interest of girls in science,
- Unfavourable attitude of girls to science learning and
- Inadequate knowledge of girls on the true nature of science.

The critical belief of biological theorists is that gender differences are natural and therefore unalterable (Olubunmi, 2001). It would be right and proper to treat boys and girls in schools differently because their natural inclinations are different roles. Thus, theories were advanced that females excelled in language based subject because of their greater and reasoning abilities yet under performed in sciences because of their lower level of innate ability of shape and form factors.

Where a school is situated says a lot about the achievement of students (Ma & Wilkins, 2002). According to Ezeudu (2003), school location means urban-rural setting. The urban-rural influence is also expected in physics just like any other science subject because of the psychosocial influence it may have on the teachers and students resulting mainly from school location. This may even dictate their academic achievement in science of which physics forms a part. Therefore, the area in which a school is located can affect the educational achievement of a student. A school in the heart of the government reserved area (G.R.A) or housing estate cannot be compared with a school located in an unsuitable place like motor garage, main street, noisy environment, and nearness to a big market among others. Noisy environment is capable of hampering teaching and learning conditions. Long journey to school can be drudgery. These variables have the potentials to influence the students' conceptual understanding.

Conceptual understanding according to Johnson (2005) refers to a person's representation of the major concepts in a system. Conceptual understanding is rich in relationships and understanding. It is a connected web of knowledge, a network in which the linking relationships are as prominent as the discrete bits of information. Conceptual understanding according to Johnson (2005) cannot be learned by rote. It must be learned by thoughtful, reflective learning. On the contrary, procedural understanding is the understanding of formal language or symbolic representations. It is the understanding of rules, algorithms, and procedures. Conceptual understanding is also known as the kind of knowledge that may be transferred between situations. The students' ability to develop conceptual understanding involves seeing the connections between concepts and procedures, and being able to apply physics principles in a variety of contexts.This is different from routine knowledge, which is knowledge that is applicable only to certain situations. For example, a student who decided to cram an aspect of a course for examination will quickly forget the crammed concepts after the examination. Conceptual understanding in physics develops when students "see the connections among concepts and procedures and can give arguments to explain why some facts are consequences of others" (National Research Council, 2001; 119). This implies that facts are no longer isolated but become organized in coherent structures based on relationships, generalizations and patterns.

Rittle-Johnson, Siegler, & Alibali, (2001) found that developing students' procedural knowledge had positive effects on their conceptual understanding, and conceptual understanding was a prerequisite for the students' ability to generate and select appropriate procedures. Thus, conceptual understanding is intertwined with procedural knowledge.

Purpose of the study

The main purpose of the study was to investigate the influence of gender and school location on the senior secondary school students' conceptual understanding of force and motion. Specifically, the study explored:

1. The influence of gender on students' conceptual understanding of force and motion.
2. The influence of school location on students' conceptual understanding of force and motion.
3. The interaction effects of gender and school location on the students' conceptual understanding of force and motion

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance

HO_1 : Gender is not a significant factor in the students' conceptual understanding of force and motion.

HO_2 : Location is not a significant factor in the students' conceptual understanding of force and motion.

HO_3 : There is no significant interaction effect of gender and school location on the students' conceptual understanding of force and motion.

METHODOLOGY

The study adopted an ex post-facto research design. Two hundred and twenty five senior secondary five physics students from six (three each from urban and rural schools) senior secondary schools within Nsukka Education zone constituted the sample for the study. These students were obtained from seven (7) intact classes form the six schools that were purposively sampled from the study area. A questionnaire known as force motion concept evaluation was used for data collection. The instrument was developed by Thornton and Sokoloff, (1998) and was adapted by the researcher. The adaptation was in terms of wording of the items of the instrument. Synonymous terms familiar to students in Nigeria was used in some cases rather than the main terms. Data collected were analyzed using mean, standard deviation and two-way analysis of variance (ANOVA).

Results

Table 1 :Descriptive statistics of students' conceptual understanding of force and motion by gender and school location

			SCHOOL LOCATION		
			Urban	Rural	**Total**
GENDER	Male	Mean	3.92	4.48	**4.11**
		SD	1.64	1.91	**1.74**
		N	64	33	**97**
	Female	Mean	4.82	4.49	**4.63**
		SD	1.39	1.39	**1.40**
		N	56	72	**128**
	Total	Mean	4.34	4.49	**4.41**
		SD	1.58	1.56	**1.57**
		N	**120**	**105**	**225**

Table 1 shows the descriptive statistics of the students' conceptual understanding as measured on the FMCE by gender and school location. With a mean score of 4.63 and a standard deviation of 1.40, the female students appeared to be superior to their male counterparts who recorded a mean score of 4.11 and standard deviation of 1.74. With respect to school location, the rural students who had a mean score of 4.49 with a standard deviation of 1.56 appeared to have demonstrated a higher conceptual understanding of force and motion than the urban students who had a mean score of 4.34 and a standard deviation of 1.58.

Table 2: Two-way (gender X location) ANOVA students' conceptual understanding of force and motion

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	25.330[a]	3	8.443	3.540	.015
Intercept	4039.896	1	4039.896	1.694E3	.000
Gender	10.447	1	10.447	4.381	.037
Location	.667	1	.667	.280	.597
Gender X Location	10.389	1	10.389	4.356	.038
Error	527.052	221	2.385		
Total	4926.000	225			
Corrected Total	552.382	224			
a. R Squared = .046 (Adjusted R Squared = .033)					

However, the result of the 2-way analysis of variance (ANOVA) in Table 2 shows that the probability associated with F value of 4.381 for the single main effect due to gender on the students' achievement on FMCE was 0.037. Since this probability value was less than the 0.05 level of significance, the null hypothesis was rejected. Hence, there was a significant main effect due to gender on the students' conceptual understanding of force and motion as measured on FMCE in favour of the female students.

On the other hand, the probability associated with F value of .280 for the single main effect due to location on the students' conceptual understanding of force and motion was .597. Since this value exceeded the 0.05 level of significance, the null hypothesis was not rejected. Thus, single main effect due to location was not statistically significant ($p<0.05$). In other words, the observed difference in the mean scores of the conceptual understanding of urban and rural students was due to a chance or sampling errors.

The probability associated with the F value of 4.356 for the interaction effect due to gender and school location was .038. Since this value was less than 0.05 level of significance, the null hypothesis was rejected. Thus there was a significant ($p<0.05$) interaction effect due to gender and location in the students' conceptual understanding of force and motion. This means that although gender was a significant factor in the students' conception of force and motion, it's effect was not consistent across the levels of location (i.e. urban and rural). This could be seen from the cell means (Table 1). Whereas for the males, rural students demonstrated a superior conceptual understanding (4.48) than their urban counterparts (3.92), for the females, the reverse was the case i.e. the urban students demonstrated a superior conceptual understanding (4.82) than their rural counterparts (4.49). The interaction in this case was a **disordinal interaction** as can be seen from the plot of the interaction in Fig. 1.

The result also revealed an adjusted R square of 0.033. This suggests that gender, location and their interaction accounted for 3.3% of the variance in students' conceptual understanding of force and motion as measured on the FMCE.

DISCUSSION

According to Nworgu (1988:119), studies on gender differences in science achievement present 'three conflicting pictures'. The first picture is that which portrays a significant gender effect in favour of males. The second picture portrays a significant gender effect in favour of females whereas the third picture is that which portrays no significant gender effect. The present study which showed that gender was a significant factor in students' conceptual understanding of force and motion as measured on the FMCE in favour of the female students fits into the second picture. This is consistent with Shaibu and Mari (1997) who observed a gender difference in achievement in science process skills in favour of the female students.

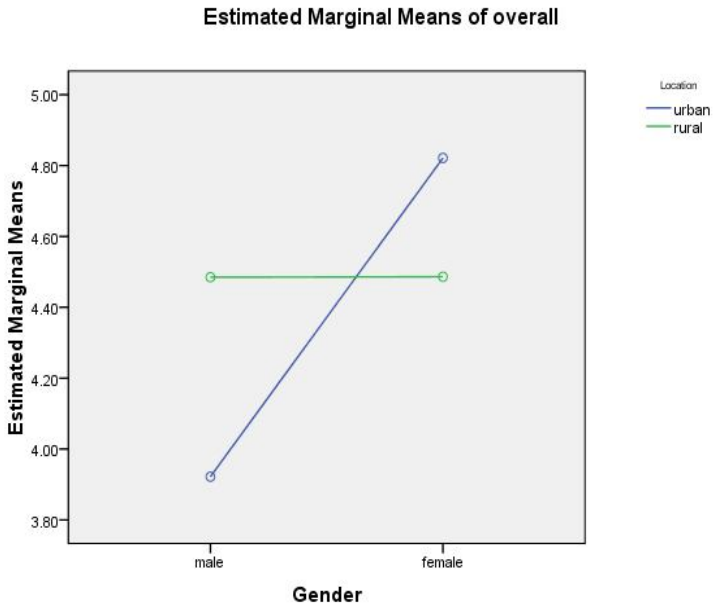

Fig 1: Plot of Marginal Means showing disordinal interaction between gender and location on students' conceptual understanding of force and motion

However it appears not to fit into the first picture which portrays a significant gender effect in favour of males as reported by Obioma (1986), Nworgu (1988), Ayogu and Nworgu (1999) in Physics; Ezeanya (2004) in chemistry; Lynch and Paterson (2002) in science process skills or the third picture which portrays no significant gender effect as in the cases of Ivowi (1983) , Daramola (1983), Nworgu (1990) in Physics. This discrepant trend trends can be explained by the findings of Nworgu (1988) in respect of gender x content area interaction in physics achievement. In other words, the area or measure of achievement used in a particular study will determine the nature/direction of gender difference.

The result of the present study in respect of location is in tandem with the studies of Jegede (1984) and Erubami (2003) which found that school location is not a significant factor in students' achievement in physics. It however differs from the findings of Nworgu (1994) and Isiugo-Abanihe and Labo-popoola (2004) which reported significant location effect in favour of urban students. The gender effect on students' conceptual understanding of force and motion was moderated by location. There was a complete reversal of the order of effect due to gender from the urban location to the rural location as evident in the *disordinal interaction* between gender and location.

CONCLUSION

The result of the analysis revealed that whereas, gender and the interaction effect of gender and location were significant ($p<0.05$) factors on students' conceptual understanding of force and motion, school location was not. Female students tended to demonstrate superior conceptual understanding of force and motion than their male counterparts. However, there was a disordinal interaction between gender and location which meant that whereas rural males showed superior conceptual understanding than their urban counterparts, the urban females outperformed the rural females. Gender, location and their interaction accounted for 3.3% of the variance in students' conceptual understanding of force and motion as measured on the FMCE.

These findings suggest a gender-sensitive approach in the planning and implementation of the physics curriculum. It is therefore recommended that physics teachers should be more gender-sensitive in their pedagogical approaches as well as in the planning of the physics curriculum.

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