GENDER DIFFERENCES IN THE LEARNING STYLES OF HIGH AND LOW ACHIEVERS IN BIOLOGY: IMPLICATIONS FOR NIGERIAN EDUCATION SYSTEM

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Abstract

Students' achievement in class is usually a product of various moderating variables, some of which are innate to the learner while, others may be demographically based. This study investigated gender-differences in the learning styles of high and low achievers in biology. Two research questions and three hypotheses guided the study. The study adopted ex-post facto research design. The sample consisted of 1062 biology students composed through multi-stage sampling technique. These were drawn from three out of the six educational zones in Anambra State. Empirical data were collated using a four-point Likert rating scale which was developed and validated by the researchers. Data analyses was done using frequency counts, chi-square statistics and a post hoc test, conducted through the Turkey/Kramer technique. Results of the study

among others indicated that collaborative and independent learning styles were more pre-disposing to high achievement in biology unlike the dependent and avoidant styles which corroborated with low achievement. Again, female students fared better under collaborative technique while males performed better under independent learning styles. The need to foster a conducive and inclusive classroom environment for the learners, irrespective of gender was pointed out.

Introduction

The effectiveness of classroom instructional process is highly dependent on the pattern of learning interaction that is prevalent. Granted that meaningful teaching and learning takes place through teacher-learner, teacher-content and learner-content interactions, the learner-learner interaction is still critical for greater efficacy (Anderson, 2003). An intrinsically motivated learner will go extra miles to satisfy his/her drive for knowledge acquisition unlike a passive learner. Perhaps, in this regard, the instructional delivery mechanism has also witnessed some modifications and changes to satisfy varied abilities, aptitudes and interests of learners. For instance, from time immemorial, the teacher was seen as the arrow-head, the beginning and the end of the instructional process. Learners have to depend entirely on him/her for the subject matter, the content, the presentation and procedures up to assessment of learning outcome. All these activities were carried out by the teacher without the aid of any form of automation. Learners then, were assumed to be blank (tabula raza) and they just have to listen to the teacher, copy notes, memorize such notes and regurgitate them whenever demanded (Anaekwe, Nnaka and Anaekwe, 2018). Avoidance learning strategy reflects passivity or inaction, and when applied to education, refers to those strategies that students should use to

learn, but they do not use them. The Avoidant and dependent learning styles developed along the premises of passivity and show similar characteristics including an inclination to goal avoidance, procrastination, worrying so much about bad grades, low attention span in class.(Shih, 2007) However, the scenario of teacher-centeredness has changed and very fast too. Teaching and learning processes are today largely liberalized and automated rather than the hither-to, analogue and regimented approach leading to learner-centered approach. The automation has given impetus to encouraging independent and collaborative learning styles. In this approach learners may cooperate with other learners as a team, to achieve a goal or may decide to work independently at his/her own pace using appropriate technologies at his/her disposal (Okebukola 1984, Johnson and Johnson, 1984). In recent times, the predominant approach globally is that the instructional process is being structured in such a way that it becomes learner-centered and activity-based as opposed to teacher-centeredness and passivity of the learner.

Science discipline is characterized as demanding activity-based learning techniques and extensive use of standard and improvised instructional materials to engender students' learning. Similarly, learners are expected to apply scientific knowledge into new situations, explore the environment, be critical, creative and innovative in thinking. Evidence abound in literature on the constraints militating against effective teaching and learning of STEM. The WAEC Chief Examiners' Report for WASSCE, 2016 for Agricultural Science, Biology, Chemistry, Mathematics and Physics) which dwelt extensively on candidates' weaknesses and suggested remedies, had earlier been reported elsewhere (Anaekwe, 2018). On a general note, Aremu and Sokan cited in Tele and Gyang (2015), stated that the search for causation of students' poor academic achievement is unending. Morakinyo (2003), attributed the poor academic performance of secondary school students to teachers' poor method of

teaching and students' unfavourable study habits, which more than any other factor has distinguished between high and low achievers in science.

High and low achievers in science, in the context of this paper refers to those students who consistently occupy the topmost and bottom positions respectively whenever students' achievement scores are ranked in descending order of magnitude. In other words, high achievers are those students whose intellectual ability are exceptionally and consistently outstanding on a high side, while the low achievers perform consistently low from the reverse direction (Ali, 1998). Although there may be different approaches towards identifying high and low achievers in a class however, Nnaka and Anaekwe (2003), adopted the students ranked in the uppermost and bottom 25% of the score continuum respectively as representing the high and low achieving groups. The learners in the middle 50% of the score continuum were regarded as students in the average category. High achievers usually demonstrate remarkable ability and potential to perform outstandingly high in academic and other spheres of human endeavour. He/she may not necessarily be a genius or a gifted child but has the potential to become one under a stimulating learning environment. Similarly, a low achiever belongs to a class of slow learners although he/she may not necessarily be one. Environmental deprivations may give rise to impoverished performance in academic ability. Some authors (Denga, 1988, Ali, 1998) have identified the characteristic features of high and low achievers. High achievers are/show persistently high and remarkable academic achievement, fast thinking, highly creative and imaginative, outstanding leadership and social skills, remarkable aptitude in special areas like music, science, language, writing etc. For the Low achievers, they show/are uninterested in learning, have poor communication ability, poor reading/social communication/interaction skills, poor in subjects that require calculations, forgets easily, scores persistently very low in tests and assessments. High and low achievers may be of any gender.

The term gender refers to economic, social and cultural attributes and opportunities associated with being male or female. Essentially, gender refers to sets of relationship, attributes, roles, beliefs and attitudes that define what being a man or a woman is within a culture. It is a socially ascribed attribute as opposed to sex which is a biological attribute (Nnaka and Anaekwe, 2000). As a result of gender roles assigned by different cultures, many women have been brought up to see science and technology and its use as reserved for the masculine gender while the biological and catering disciplines are associated to feminine gender. It is known that the wrong perception of science and technology as male-oriented course by the society is still affecting female participation in science-related disciplines and activities. However, Ifamuyiwa (2013), had reported an inconclusive result on the influence of gender on computer anxiety, knowledge and utilization among secondary school learners.

The fore-going presentation shows that both high and low achievers abound in all classrooms although environmental conditions may impose some limits to the manifestation of each category. Whereas it would be the utmost desire of any teacher that high achievers predominates in his/her class, it is well, a truism that we cannot run away from the challenges posed by low achievers in a normal classroom. This calls for some clinical approaches to identifying and handling these extreme learning situations in a learning environment. Of all the possible predisposing factors to enhanced achievement in science, this paper examines the pattern of learning styles adopted by high and low achievers. It could as well, be possible that some demographic factors including gender, location, class level, teaching experience etc, are contributory to the favoured learning styles. The purpose of this study however, was to identify the learning styles of high and low achievers in science as well as to determine the influence of gender on the independent variable.

Statement of the problem

The utmost desire of any teacher is that high achievers predominates in his/her class. However, it is a truism that one cannot run away from the challenges posed by low achievers in a normal classroom. Some innate and environmental factors imposed these restrictions on the ability of this category of learners. Low- achievers tend to render the efforts of the teacher useless thereby lowering his/her morale to function effectively. The teacher however, strives to carry everyone along in his/her desire to deliver on his objectives, through continuous adjustment of his/her instructional strategies. However, the learning styles adopted by the learners themselves are of critical importance in determining his/her achievement-potential. Similarly, some predisposing factors also tend to moderate quality and quantity of achievement in science. This paper examines the pattern of learning styles adopted by high and low achievers as well as, the influence of gender on the favoured learning styles in enhancing achievement in biology. The problem of this study therefore, is : how has gender-differences in the learning styles of high and low achievers influenced their achievement in biology?

Research question

i.   What proportion of high and low achievers in science utilized the various learning styles?

ii. What proportion of male and female science students utilized the various learning styles?

Hypotheses:

Ho1: The proportion of high and low achievers in science who utilized the various learning styles will not differ significantly.

Ho2: The proportion of male and female science students who utilized the various learning styles will not differ significantly.

Ho3: The proportion of science students who utilized the four different learning styles will not differ significantly.

Methodology:

This study adopted the ex-post facto research design. According to Kerlinger (1979:379), in this type of design "scientists cannot directly control the independent because their effects or manipulations have already occurred or because they are inherently not manipulable". Thus the science students are already streamed along their preferred learning styles and gender levels, and the researchers were only investigating the effects of these independent variables on their (students') academic ability. The sample consisted of one thousand and sixty-two (1062) senior secondary, year three (SS3) biology students drawn from three out of the six education zones in Anambra state. SS3 students were deemed fit for the study since, being final year students, they would have adopted particular learning styles/habits, unlike those students who are fresh beginners. Biology students were deemed appropriate for the study because a reasonable number of students offer biology in their final examination relative to other science subjects like chemistry and physics. This large number was needed to ensure a fair spread of students across the different learning styles. The sample was proportionately drawn from the zones with respect to gender levels. Ten secondary schools from each of the chosen zones were sampled through balloting, while ten percent of the students in each zone were sampled and administered with the instrument for data collection as shown in table 1.

Table 1: Distribution of Respondents by Education Zones and Gender:

Education Zones	Male		Female		Total	
Aguata	878	(87)	2028	(202)	2906	(290)
Ogidi	1466	(146)	2699	(269)	4165	(416)
Awka	1159	(115)	2391	(239)	3550	(355)
Total	3503	(350)	7118	(712)	10621	(1062)

Number outside parentheses = population; number inside parentheses = sample

A Questionnaire on students' learning styles developed and validated by the researchers was used for data collection. The instrument was modeled after 4-point Likert rating scale and covered four basic learning styles namely: Collaborative, Independent, Dependent and Avoidant. The respondents were requested to indicate their extent of agreement or disagreement with the items in each of the learning styles, as describing his/her typical/preferred learning styles. The responses and weightings ranged from Strongly Agree (SA=4), Agree (AG=3), Disagree (DI=2) to Strongly Disagree (SD=1). The reliability of the instrument was determined through the Cronbach Alpha technique and yielded an index of 0.75, which was adjudged to be high enough and reliable for the study. The validity of the instrument was ensured through consultation with other experts in educational measurements and evaluation. The instrument was administered to the SS3 biology students in the sampled schools in the first term of the 2016/2017 academic session. Their respective Form masters served as research assistants for the study. Secondly, the students' biology scores in the three previous terms of SS2 were collated from their former form masters. These scores were averaged and used to stratify the students in their ability level. To achieve this, the average scores were arranged in a continuum, with the uppermost 25% and bottom 25% representing high and low achievers, respectively. The research questions were answered using frequency counts. Hypotheses were tested at 0.05 level of significance with chi-square statistics and post hoc test using Turkey Kramer method.

Results:

Table 2: Proportion of High and Low Achievers who utilized various Learning Styles.

Learning Styles	High Achievers	Low Achievers	Total	df	χ^2-Cal.	χ^2-Crit.	Decision

Collaborative	153	91	244	1	15.75*	3.84	Reject Ho1 for *
Dependent	62	80	142	1	2.28		
Independent	23	2	28	1	16.06*		
Avoidant	58	60	118	1	0.04		

*= significant beyond 0.05 level of significance

From table 2, a greater proportion of the high achieving students utilized the collaborative and independent learning styles while, a greater proportion of the low achievers utilized the dependent and avoidant learning styles. The calculated chi-square values of collaborative (15.75) and independent (16.06), learning styles were greater than the critical Chi-square value of 3.84 at 0.05 level of significance.

Table 3: Proportion of Male and Female students who utilized various Learning Styles.

Learning Styles	Male	Female	Total	df	χ^2-Cal.	χ^2-Crit.	Decision
Collaborative	78	166	244	1	31.74*		Reject
Dependent	67	75	142	1	0.46		Ho2 for
Independent	21	7	28	1	7.00*	**3.84**	*
Avoidant	54	64	118	1	0.84		

*= significant beyond 0.05 level of significance

From table 3, a greater proportion of females utilized the collaborative learning styles while, a greater proportion of the males utilized the independent learning styles. The calculated chi-square values of collaborative (31.74) and independent (7.00), learning styles, which favoured respectively female and male biology students, were greater than the critical Chi-square value of 3.84 at 0.05 level of significance, for df = 1.

Table 4: Proportion of Biology Students who utilized various Learning Styles.

Learning Styles	Observed frequency	Expected frequency	Total	Df	χ^2-Cal.	χ^2-Crit.	Decision
Collaborative	244	133	244	3			Reject Ho3
Dependent	142	133	142	3	117.82	**7.8**	
Independent	28	133	28	3	*	**1**	
Avoidant	118	133	118	3			

*= significant beyond 0.05 level of significance

From table 4, it was seen that the proportion of biology students who utilized the different learning styles differed significantly since the calculated value (117.82) was greater than the critical chi-square value (7.81), at 3 degree of freedom and 0.05 level of significance.

Table 5: Post Hoc Pair-wise Comparison of Mean Scores using Turkey/Kramer method.

Learning Styles	Mean	Dfwr	Q-Cal.	Q-Crit.

Collaborative	58.00	1058	4	65.30*	
Dependent	37.00				
Collaborative	58.00	1058	4	52.50*	
Independent	41.0				
Collaborative	58.00	1058	4	48.00*	
Avoidant	36.00				3.63
Independent	41.00	1058	4	13.70*	
Dependent	37.00				
Independent	41.00	1058	4	11.40*	
Avoidant	36.00				
Dependent	37.00	1058	4	1.70	
Avoidant	36.00				

*= significant beyond 0.05 level of significance for r = 4 & dfw = 1058.

From table 5, it was evident that the significant difference resulted from the difference in the paired means of collaborative with all the other three learning styles, as well as Independent versus dependent and avoidant learning styles respectively. The mean difference between the pair of dependent and avoidant learning styles was not significant.

Discussion:

From table 2, it was obvious that a greater proportion of the high achieving students utilized, the collaborative and independent learning styles. Similarly, a greater proportion of the low achievers utilized the dependent and avoidant learning styles. Indeed a significant difference existed between the proportions of high and low achievers who utilized the various learning styles in favour of collaborative and independent learners. Since the calculated chi-square values of collaborative (15.75) and independent (16.06), learning styles were greater than the critical value of 3.84 at 0.05 level of significance, for r = 4

and within degree of freedom = 1058, it implies that the two learning styles tended to facilitate biology achievement significantly, unlike the other learning styles. The superiority of collaborative and independent learning styles in enhancing academic achievement of science students had been reported (Okebukola, 1984; Nnaka and Anaekwe, 2003; Igboanugo 2011, Nwoye and Okeke, 2020). These learning styles have the potential of engendering active participation and creativity in learning science. On the other hand, Karl (1964), reported that Dependent and avoidant learning styles tended to be defective to the study of science. They indeed, characterize slow learners' intellectual pursuit. Little wonder, students that utilize these learning styles are usually disposed to extreme passivity to the study of science. Indeed learning styles play significant roles in academic achievement and other affective attributes of the learner (Fletecher, 2016, Nwankwo and Ibeh, 2018).

From table 3, a greater proportion of females utilized the collaborative learning styles while a greater proportion of the males utilized the independent learning styles. Again, a significant difference existed between the proportions of male and female students who utilized the collaborative and independent learning styles in favour of females and males respectively, unlike the proportion that utilized dependent and avoidant learning styles. The calculated chi-square values of collaborative (31.74) and independent (7.00), learning styles, which favoured respectively female and male biology students, were greater than the critical Chi-square value of 3.84 at 0.05 level of significance, for one degree of freedom. A possible explanation for the observed preferred learning styles of male and female biology students could be sought from the fact that most males are naturally adventurous, eager to explore situations and work independently, while many females have the natural tendency to be dependent on someone or assisted in the performance of a duty. These natural traits could have had great influence on their preferred learning styles.

From table 4, it was seen that the proportion of biology students who utilized the different learning styles differed significantly, since the calculated chi-square value (117.82) was greater than the critical value (7.81), at 3 degree of freedom and 0.05 level of significance. To determine the direction of the difference, post hoc test was conducted. As seen from table 5, it was evident that the significant difference resulted from the differences in the paired means of collaborative learning styles with all the other three learning styles individually, as well as Independent versus dependent and avoidant learning styles respectively. The mean difference between the pair of dependent and avoidant learning styles was not significant. This implied that the collaborative mode tended to be most effective, followed by independent mode, out of the four learning styles, in facilitating students' achievement in biology. Dependent and avoidant modes tended to be defective and as such need to be discouraged.

Implication for Nigerian education system

The findings of this study have great implications for the improvement of the Nigerian education system in a number of ways, including but not limited to the need for/to:

i. provision of conducive classroom environment, enriched with valuable resource materials for fostering activity-based learning in biology. Similarly, instructional materials, rich in local content should be emphasized through improvisation(Anaekwe, 2020).

ii. establishment of special science/gifted-in-science schools to nurture and groom such high achievers in science to excel in their areas of ability, aptitude and skills. This approach might encourage healthier competition among and between school types.

iii. foster inclusiveness in the classroom irrespective of gender or other demographic variables. Gender-inclusive education system strives to provide optimal conditions for enhanced learning by all students, irrespective of gender.

Thus, both males and females should be adequately catered for by the Nigerian education system through her prescribed instructional strategies.

iv. encourage the use of collaborative and independent learning styles among learners since they have the tendency to facilitate achievement in learning. By implication, biology teachers should be optimally updated on these instructional strategies.

Conclusion

This study investigated gender-differences in the learning styles of high and low achieving students in biology. Two research questions and three hypotheses guided the study. The study adopted ex-pot facto research design. The sample consisted of 1064 science students composed through multi-stage sampling technique. These were drawn from three out of the six educational zones in Anambra State. Empirical data were collated using a four-point Likert rating scale which was developed and validated by the researchers, assisted by the form teachers who served as research assistants. The respondents were requested to indicate their extent of agreement or disagreement with the items in the instrument as describing his/her typical/preferred learning styles. The responses and weightings ranged from Strongly Agree (SA=4), Agree (AG=3), Disagree (DI=2) to Strongly Disagree (SD=1). Data analyses was done using frequency counts, chi-square statistics and a post hoc test, conducted through the Turkey/Kramer technique. Results of the study among others indicated that collaborative and independent learning styles were more pre-disposing to high achievement in science unlike the dependent and avoidant styles which corroborated to low achievement. Again, female students fared better under collaborative technique while males were better under independent learning styles. Implications of the findings in the areas of establishing special/gifted-in science schools, foster conducive and inclusive classroom environment for the learners, irrespective of gender ware emphasized.

Recommendation

The result of this study has provided empirical evidence to the fact that collaborative/cooperative and independent learning styles are significantly achievement-oriented in biology classes and therefore, needs to be encouraged among students. Similarly, dependent and avoidant learning styles need to be de-emphasized among learners because they are defective in fostering learning outcomes in biology. In view of the fore-going, it was recommended that:

i. students should be encouraged to adopt collaborative and independent learning styles in studying biology as an effective learning strategy;

ii. Biology teachers should regularly attend conferences and workshops organized by professional associations to update their skills on the potentialities of some innovative learning strategies in science;

iii. Collaborative learning style should be encouraged especially among female students as a way of bridging the gender-gap among science students.

iv. Basic instructional materials should be provided to facilitate activity-based learning among biology students and teachers should be encouraged to improvise unavailable standard materials.

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