Article

INFLUENCE OF GENDER ON STUDENTS' INTEREST AND ACHIEVEMENT IN GENETICS USING TWO CONSTRUCTIVIST INSTRUCTIONAL MODELS IN SECONDARY SCHOOLS IN ENUGU STATE, NIGERIA

Assumpta Chinyere Aham, Obiageli Loretta Aniaku, & Chidinma Blessing Anita Ugwu

Department of Science Education, University of Nigeria, Nsukka.

obiageli.aniaku@unn.edu.ng (Obiageli Loretta Aniaku)

Abstract

This study investigated the influence of gender on students' interest and achievement in Genetics using two constructivist instructional models. Two research questions and two hypotheses guided the study. Quasi-experimental research design, specifically the non-equivalent control group design, was adopted for the study. The population of the study comprises 1,986 (816 male and 1,170 female) SS111 Biology students in 31 public secondary schools in Enugu Education Zone, Enugu State, Nigeria. A sample size of 160 (79 male and 81 female) SS111 Biology students selected through a multistage sampling technique was used for the study. The instruments for data collection were Genetics Interest Inventory (GII) and the Genetics Achievement Test (GAT). The internal consistency reliability coefficient of 0.64 was obtained using the Kuder-Richardson formula (K-R 20). The research questions were answered using mean and standard deviation, while the hypotheses were tested using analysis of covariance (ANCOVA) at 0.05 level of significance. The findings of the study revealed that there is no significant difference between gender and students' interest and achievement in Genetics using two constructivist instructional models. The study therefore recommended that Biology teachers should encourage both male and female students to engage in participatory learning using two constructivist instructional models, which were found to be effective in enhancing students' interest and achievement in Genetics.

Keywords: Achievement, 5Es and PEDDA Constructivist instructional models, Gender, Genetics, Interest

Introduction

The advancement in Genetics is a great way of promoting the increase in biological knowledge and eradicating gender disparities in the learning environment. For advancement in Genetics which involves new possibilities in medicine, agriculture, and environmental science to take place, a good foundation of Genetics is required which starts from the secondary school (Adelana et al., 2023). Ababneh and Samad (2018) remarked that though boys and girls are encouraged to learn Genetics because it is essential in our daily living, there is gender difference which has resulted in girls being disadvantaged in Biology teaching and learning. For girls to have the same opportunities as boys in Biology, equal preparation should be provided for them in learning Genetics. This may involve teachers engaging the male and female students in knowledge construction using the constructivist instructional models (CIMs) and properly understanding how gender influences the learning of Genetics.

Gender difference has remained an issue of concern in education particularly in Biology because it is an important variable that influences the learning of Genetics. According to Imanda (2025), gender equity can be observed in the biology classroom when the teacher recognizes the differences in ability and circumstances of both boys and girls and act to ensure that no one is disadvantaged. Certain subjects are considered gender-related, for instance, Biology, which is often considered a "female" subject

(Onyegegbu, 2018). Uitto, (2014) opined that those girls like Genetics because it deals with health and nature. This opposes the statement made by UNESCO (2023) that there are too many girls that are affected by gender differences, and this eventually influence the subjects they study particularly Biology. This also tallies with the submission of Ahmadu and Nwankwo (2019) that Nigerian curriculum is gender biased since it portrays the role of males while female is faced with discrimination. It was further explained that gender bias is not only a problem for girls in Northern Nigeria (Abudllahi et al., 2019) but also a big barrier for boys in Southern Nigeria. Gender discrimination may result in girls lacking interest in Genetics because girls tend to go for subjects that do not require much energy and brain-tasking.

The influence of gender varies from one study to another. Gisio and Mugwiria (2024) stated that there are many positive findings on the relationship between gender and academic achievement in Biology. Some researchers reported from the result of the findings of their study that gender has no influence on achievement in Biology (Giso & Mugwiria, 2024; Safitri et al., 2024). Amedu (2015) in a separate study reported that boys achieve higher than girls in Biology. While Ullah and Ullah (2019) reported that girls outperform the boys in educational setting across the world. The reports of gender-related researchers on students' interest and achievement in Genetics are conflicting. Hence, there is a need to find out the influence of gender on students' interest and achievement in Genetics using the CIMs.

Genetics is a topic in the final year Biology curriculum in secondary schools. Genetics is highly recognized for improving our living conditions by producing high-yielding, disease-resistant plants and animals and developing early maturing varieties of plants and animals. According to Onyejekwe et al. (2018), Genetics, which is the investigation of inherited and variable life features, has enabled students to understand the benefits of inheritance. Students learn accurate ways of explaining genetic defects, for instance, sickle cell disease, rather than relying on superstition and other mystical explanations. This implies that the teaching and learning of Biology should help students to make an impact on various aspects of life, especially in understanding health and the hereditary aspects of life (Adeyimi et al., 2020). Students should acquire sound knowledge of Biology at the secondary school level to prepare them to pursue science courses such as Medical Science and Genetic Engineering (Buba et al., 2020). Good knowledge of Genetics is acquired when teachers' ability is combined with appropriate teaching methods and gender to sustain high interest of students.

The field of Genetics depends on the key factor known as interest. Interest is the foundation of learning because when one is interested in learning Genetics one is likely to be deeply involved and inspired to learn. Onyi and Njoku (2019), stated that interest in the pedagogical context can be defined as the student's willingness to engage in an academic task. Interest simply means the attention that is paid to continue with an experience. Some empirical studies have shown that interest has a significant positive effect on achievement of students in Biology (Audu, 2018; Owoye & Agbaje, 2016). On the other hand, Agogo and Naaka (2014) revealed that 5Es CIM was effective in improving the interest of students in Genetics. This could be because students' interest in Biology is enhanced by teaching Genetics using real world application to have high achievement.

There are many problems facing the teaching and learning of Genetics, which result in poor achievement in Genetics. WAEC chief examiners' report (2020) revealed that the result was poorer than the previous year. The poor achievement in SSCE Biology may be attributed to their perceived difficulties in Genetics which is regarded as complex and abstract (Abdulhamid et al., 2023) and students avoid attempting questions on them while writing their terminal examination in Biology (Adelana et al., 2021). This could be because the predominant teaching method (lecture) has many negative implications, such as poor time management, content overload, boredom, being placed last in the curriculum, and being less innovative (Ahmadu & Nwankwo, 2019). To address this issue of

teaching and learning of Genetics, the influence of gender is considered to improve students' interest and achievement in Genetics.

In recognition of the importance of improving the interest and achievement of students in Genetics, several efforts are made to encourage teachers to employ pedagogies that engage students in participatory learning. To actualize this objective, it is pertinent to consider the teaching method that has a major concern for gender, and this calls for highly sophisticated teaching known as constructivism (Ugwuoke et al., 2020). Umar et al. (2023) viewed constructivism as students actively building new knowledge based on the present and experience by either reconciling or discarding it. In this case, the student is active by constructing knowledge and using prior knowledge and skills to solve any problem. It was suggested that the difficulties in understanding Genetics could be overcome by using experimental-based learning (Safitri, et al., 2024; Ezechi, 2021) such as the CIM.

The 5Es CIM encourages the active involvement of students and follows a step-by-step progression where each step is based on the previous step. Students can be active by working independently or in groups during the phases of 5Es (Engagement, Exploration, Explanation, Elaboration, and Evaluation). Ajayi and Eravwoke (2012) revealed that girls performed better than boys in interest and achievement in Biology when taught using 5Es CIM. While Buba, Bamus and Adamu (2020) reported that constructivist method of teaching Biology is effective irrespective of gender. The reports of gender-related researchers on students' interest and achievement in Genetics using 5Es CIM are conflicting. Hence, there is a need to find out the influence of gender on students' interest and achievement in Genetics using the 5Es and PEDDA CIMs.

PEDDA CIM is a conceptual change CIM employed in this study. The five steps in PEDDA CIM are listed as Prior knowledge, Exploration, Discussion, Dissatisfaction and Application. Ezechi (2017) suggested that in using PEDDA CIM, teachers should recognize the prior conception of students before instruction because most of these alternative conceptions are unscientific and if neglected have negative impact on teaching and learning. Ezechi (2017) revealed that female students performed better than the males when taught Genetics using conceptual change CIM. Amaefuna and Ezeliora (2020) reported that 5 steps CIM (PEDDA) facilitated the interest and achievement of students in Biology and there was no significant difference in achievement of male and female students when taught Biology using 5 steps CIM (PEDDA). Nigeria needs to adopt the best instructional models in Genetics by promoting the students' interest and achievement and placing both male and female students at the base of the teaching process. It is quite clear that the problem of poor achievement cannot be solved without improving on the interest of students in Genetics. Some studies on achievement of students in Genetics have been influenced by gender showing that participation rates are not the same for boys and girls because there is discrimination against girls. This poor achievement has led to students not achieving their academic career choice in areas requiring Genetics. This poor students' achievement could be because of teachers' ineffectiveness in employing instructional models that could engage the boys and girls equally in learning Genetics.

Unfortunately, students' achievement in Genetics has remained poor despite the findings of the instructional models. In trying to provide an answer to the problem, it has been deduced from empirical evidence that CIMs could enhance interest and achievement in Genetics. Since 5Es and PEDDA CIMs are designed to help the students to be active and share their knowledge in Genetics, there is need to investigate the influence of gender on students' interest and achievement in Genetics taught using 5Es and PEDDA CIMs. Therefore, the focus of this study is to investigate the influence of gender on students' interest and achievement in Genetics using the 5Es and PEDDA CIMs. The purpose of this study was to investigate the influence of gender on students' interest and achievement in Genetics taught using 5Es and PEDDA CIMs. The following research questions were raised for the study.

1. 1.What is the influence of gender on students' mean interest ratings in Genetics?
2. What is the influence of gender on students' mean achievement scores in Genetics?

Methodology

Quasi-experimental research design, specifically the non-equivalent control group design, was used for the study. The population of the study comprised 1,986 SSIII Biology students in 31 public secondary schools in Enugu Education Zone, Enugu State, Nigeria. The sample of this study comprised 160 (79 male and 81 female) SSIII Biology students using a multistage sampling technique. Firstly, simple random sampling was used to select 2 out of the 3 local government areas in the zone. Secondly, stratified random schools were used to sample 23 coeducational schools, and thirdly, a purposive sampling technique was used to select 4 coeducational schools, which were selected from the 2 sampled L.G.A.s based on gender. At the last stage, simple random sampling was used to select two intact classes for the first and second experimental groups (A and B) taught using 5Es and PEDDA CIMs. To create a constructivist instructional environment, the 4 Biology teachers were trained using the 5Es CIM and PEDDA CIMs. The research instruments were titled Genetics Interest Inventory (GII) with 25 items and Genetics Achievement Test (GAT) with 40 multiple choice items. The validation of GII and GAT was carried out by three experts, one from the Biology Education unit, one from the Measurement and Evaluation unit, both from the Department of Science Education, and one from Educational Psychology, from the Department of Educational Foundations, University of Nigeria, Nsukka. The internal consistency reliability coefficient of the items of the instruments obtained using Kuder Richardson 20 (K-R 20) was 0.64. Data collected were analyzed using mean and standard deviation to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

The result in Table 1 shows the influence of gender on the mean interest ratings of students in Genetics. The result shows that male students had mean interest ratings ("X" $^{-}$= 37.65, SD = 8.49) on the pre-test and mean interest ratings of ("X" $^{-}$= 50.13, SD = 7.32) on the post-test. The mean difference for the male students' interest rating in Genetics was 12.48. On the other hand, the female students had a mean interest rating of ("X" $^{-}$= 38.10, SD = 7.38) on the pre-test and a mean interest rating of ("X" $^{-}$= 51.22, SD = 9.75) at post-test. The mean difference obtained for the female students' interest ratings in Genetics was 13.12. Summarily, the result shows that female students demonstrate a slightly higher interest in Genetics than their male counterparts.

Table 1: Pre-test and post-test Influence of Gender on Students' mean interest ratings in Genetics.

Gender		Pre-test		Post-test		
	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean Difference
Male	79	37.65	8.49	50.13	7.32	12.48
Female	81	38.10	7.38	51.22	9.75	13.12

Note: N = Number of Respondents, "X" $^{-}$= Mean, SD = Standard deviation

Table 2 also shows ANCOVA analysis of the significant difference in the mean interest ratings of male and female students in Genetics. The result shows that an f-ratio of (F (1, 159) = 3.514, p = 0.063, η^2_p = .022) was obtained. Given that the associated probability value of 0.063 is greater than 0.05 level of significance, the null hypothesis one (H01) which states that there is no significant difference in the mean interest ratings of male and female students in Genetics is therefore not rejected. Furthermore, the effect size of (η^2_p = .022) indicates that 2.2 percent variance in the interest ratings of students in Genetics is explained by gender difference. Therefore, the inference drawn is that there is no significant

difference in the mean interest ratings of male and female students in Genetics. This also implies that gender is not a significant factor in determining students' interest in Genetics.

Table 2: Analysis of Covariance (ANCOVA) of the significant difference in the mean interest ratings of students taught Genetics using 5Es and PEDDA constructivist instructional models.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Dec.
Corrected Model	4410.368[a]	4	1102.592	10.172	.000	.208	
Intercept	6218.043	1	6218.043	57.362	.000	.270	
InterestPretest	3239.053	1	3239.053	29.881	.000	.162	
Group	495.355	1	495.355	4.570	.034	.029	S
Gender	380.935	1	380.935	3.514	.063	.022	NS
Group *Gender	674.419	1	674.419	6.222	.061	.039	NS
Error	16801.876	155	108.399				
Total	506423.000	160					
Corrected Total	21212.244	159					

Note: S = Significant, NS = Not Significant and η^2_p = partial eta squared

The result in Table 3 shows the influence of gender on the mean achievement scores of students in Genetics. The result shows that male students had a mean achievement score of ("X" ¯= 44.13, SD = 8.00) at pre-test and a mean achievement score of ("X" ¯= 61.08, SD = 9.07) at post-test. The mean difference obtained for the male students' achievement score in Genetics was 16.95. On the other hand, the female students had a mean achievement score of ("X" ¯= 44.72, SD = 6.31) at pre-test and a mean achievement score of ("X" ¯= 62.18, SD = 7.94) at post-test. The mean difference obtained for the female students' achievement score in Genetics was 17.46. Consequently, the result shows that female students performed slightly better than their male counterparts in Genetics.

Table 3: Pre-test and post-test Influence of Gender on Students' mean achievement scores in Genetics.

Gender		Pre-test		Post-test		
	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean Difference
Male	79	44.13	8.00	61.08	9.07	16.95
Female	81	44.72	6.31	62.18	7.94	17.46

Note: N = Number of Respondents, $\bar{X}$= Mean, SD = Standard deviation

Table 4 also shows ANCOVA analysis of the significant difference in the mean achievement scores of male and female students in Genetics. The result shows that an f-ratio of (F (1, 159) = 1.579, p = 0.211, η^2_p = 0.023) was obtained. Given that the associated probability value of 0.211 is greater than 0.05 level of significance, the null hypothesis two (H02) which states that there is no significant difference in the mean achievement scores of male and female students in Genetics is therefore not rejected. Furthermore, the effect size of (η^2_p= .023) indicates that a 2.3 percent variance in the achievement scores of students in Genetics is explained by gender difference. The inference drawn is that male and female students did not differ significantly in their achievement in Genetics. Therefore, gender is not a significant factor in determining students' achievement in Genetics.

Table 4: Analysis of Covariance (ANCOVA) of the significant difference in the mean achievement scores of male and female students taught Genetics using 5Es and PEDDA constructivist instructional models.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Dec.
Corrected Model	6754.252[a]	4	1688.563	28.969	.000	.428	
Intercept	1382.844	1	1382.844	23.724	.000	.133	
Actpretest	5213.278	1	5213.278	89.439	.000	.366	
Group	498.793	1	498.793	8.557	.004	.052	S
Gender	92.016	1	92.016	1.579	.211	.010	NS
Group *Gender	919.462	1	919.462	15.774	.120	.092	NS
Error	9034.723	155	58.289				
Total	529038.000	160					
Corrected Total	15788.975	159					

Discussion

The findings of this study indicated that the influence of gender on students' interest and achievement in Genetics using 5Es and PEDDA CIMs was not significant. The findings of this study agree with Ugwuoke, Oguama and Ugwuanyi (2020) who revealed that there was no significant difference between the mean achievement scores of male and female students taught Physics using 5Es CIM. The findings of this study are consistent with Agogo and Naaka (2014) who found out that 5Es facilitated students' interest in Genetics. In addition, the findings of this study also agree with the findings of Owoye and Agbaje (2016) who found that gender has no significant influence on the interest of students in Biology. This might be because the students have the same learning experience and environment. The findings of this study disagree with the view of Amedu (2015) who revealed that male students performed better than their female counterparts in Biology. More so, the findings of this study are in line with Amaefuna and Ezeliora (2020) and Ezechi (2017) who found out that there was no significant influence of gender on students' interest and achievement in Biology when taught using conceptual change (PEDDA) model.

Conclusion

Influence of gender on students' interest and achievement in Genetics using 5Es and PEDDA CIMs is not significant. This implies that the two CIMs are effective in enhancing students' interest and achievement in Genetics since there in no discrimination and the classroom environment is gender friendly. It has been revealed that the problem of poor interest and achievement in Genetics could be corrected by the teachers eliminating stereotypes to ensure students' active participation in the classroom. This enables students to construct new knowledge as well as enhance interest and achievement in Genetics. Gender differences have been identified as a problem for teachers not exposing both male and female students to teamwork using 5Es and PEDDA CIMs. 5Es and PEDDA CIMs encourage meaningful learning as students contribute their ideas through the construction of knowledge. It has been revealed from the findings of the study that there was no significant difference between the influence of gender and students' interest and achievement in Genetics using the two CIMs. This implies that both male and female students had enhanced interest and achievement since the two CIMs helped to create a gender-friendly environment. Teachers should encourage activity-oriented

learning using 5Es and PEDDA CIMs in both male and female students to facilitate interest and achievement. School administrators should embark on the supervision of the teachers to ensure that both male and female students are given equal opportunities in class activities when using 5Es and PEDDA CIMs to enhance interest and achievement.

References

1. Ababneh, E., & Samad, M. (2018). Gender gap in science achievement for Jordian students in PISA2015. European Journal of Educational Research, 7(4), 963-974.
2. Abdullahi, N., Abubakar, A., Abubakar, M. J., & Aliyu, A. C. (2019). Gender gap in science and technology education in Nigeria. International Journal of Education and Evaluation, 5(3), 1-13.
3. Abdulhamid, K., Zayum, D. S., & Jibrin, A. G. (2023). Effect of problem-based learning on academic achievement in genetics among senior secondary school students in Bauchi state. African Journal of Science, Technology Mathematics and Engineering, (AJSTME), 9(6), 472-478.
4. Adelana, O. P., Akinsulure, A. O., Ajose, M. A., & Ishola, A. M. (2023). Perceptions of genetics difficulty among secondary students. Journal of Science and Mathematics Letters, 11(1), 51-58.
5. Adelana, O. P., Ishola, A. M., & Adeeko, O. (2021). Development and validation of instructional package from teaching and learning genetics in secondary schools. Asian Journal of Assessment in teaching and learning, 11(2), 32-41.
6. Adeyimi S. A, Nzabalirwa, W. & Shivoga, W. A. (2020). Age, gender and verbal ability as predictors of students' achievement in biology. International Journal of Studies in Education and Science (IJSES), 1(1), 80-91.
7. Agogo, P. O., & Naakaa, D. A. (2014). Effects of 5es constructivist instructional strategy on students' interest in senior secondary genetics in Gwer L. G. A., Benue state. Global Journal of Environmental Science and Technology, 1(2), 015-019.
8. Ahmadu, S. K., & Nwankwo, O. C. (2019). Effect of constructivist pedagogy on performance in biology among secondary school students in Kogi state. Journal of Education in Developing Areas, JEDA, 27(2), 202-207.
9. Ajayi, O. A. & Eravwoke, U. O. (2012). Effects of 5e learning cycle on students' achievement in biology and chemistry. Cyproit Journal of Educational Sciences, 7(3), 244-262.
10. Amaefuna, A. I., & Ezeliora, B. A. (2020). Effect of 5 step constructivist-based instructional model in students' achievement in biology. Greener Journal of Education Research, 11(1), 1-5.
11. Amedu, O. I. (2015). The effect of gender on the achievement of students in biology using Jigsaw method. Journal of Education and Practice, 6(17), 176-179.
12. Audu, C. T. (2018). Influence of teaching styles on students' achievement and interest among biology students in secondary schools in Taraba state, Nigeria. Advances in Social Sciences Research Journal, 5(5), 164-172.
13. Buba, A. M., Banus, A. A., & Adamu, M. (2020). Gender difference in effectiveness of constructivist method of teaching biology on academic performance of senior secondary school students in Maduguri metropolis, Borno state, Nigeria. African Journal of Science, Technology

and Mathematics Education (AJSTME), 5(1), 41-17.

14. Ezechi, N. G. (2021). The problems of teaching and learning genetics in secondary schools in Enugu South Local Government Area of Enugu state. British International Journal of Education and Social Sciences, 8(4), 13-19.
15. Ezechi, N. G. (2017). Facilitating students understanding of biological phenomena using conceptual change instructional model in Enugu metropolis, Nigeria. Literacy Information and Computer Education Journal (LICEJ), 8(4), 2775-2780.
16. Gisio, J. M., & Mugwiria, R. (2024). Influence of gender on students' academic achievement in biology when taught using experiential learning approach in secondary schools in Maara Subcounty, Kenya. International Journal of Research and Innovation in Social Science (IJRISS), VIII (IX), 2666-2675.
17. Imanda, C. O. (2025). Gender influence on learners' attitude towards biology: A pedagogical focus on science process skills. International Journal of Research and Innovation in Applied Science (IJRIAS), x(vii), 1581-1591.
18. Owoye, P. O., & Agbaje, R. O. (2016). Students' attitude and gender as correlates of students' performance in biology in senior secondary school. International Journal of Research and Analytical Review (IJRAR), 3(3), 72-80.
19. Onyegegbu, N. (2018). Enhancing Nigerian girls' potentials in science. Breaking barriers into stem career. Perspectives in Science and Technology Education in Nigeria. Great AP Express Publishers Ltd, Nsukka.
20. Onyejekwe, C. A., Uchendu C. G. & Nnom, T. (2018). Effects of concept mapping on students' performance in genetics in selected public schools in Obio/Akpor. International Journal of Education and Evaluation, 4(1), 54 - 60.
21. Onyi, I. E., & Njoku, Z. C. (2019). Problem-solving instructional approach (Psia) for effective learning of stoichiometry in secondary school chemistry. Review of Education, Institute of Education Journal, University of Nigeria, Nsukka. 31(II), 215-225.
22. Safitri, D., Zubaidah, S., Gofur, A., & Lestari, S. R. (2024). Academic level and gender-based mapping of higher school students' genetic literacy: A cross sectional study in Indonesia. Uniciencia, 38(1), 1-26.
23. Ugwuoke, U. U. & Oguama, B. E., & Ugwuanyi, C. I. (2020). Effect of 5es constructivist instructional strategy on secondary school physics students' achievement in Enugu education zone. African Journal of Science, Technology and Mathematics Education (AJSTME), 5(1), 28-34.
24. Uitto, A. (2014). Interest, Attitude, and self-efficacy beliefs explaining upper secondary school students' orientation towards biology related careers. International Journal of Science and Mathematics Education., 12, 1425-1444.
25. Ullah, R. & Ullah, H. (2019). Boys versus girls' educational performance: Empirical evidence from global north and global south. African Educational Research Journal, 7(4), 163-167.
26. Umar, Y. M., Kabiru, F., & Ibrahim, A. A. (2023). Effect of 5es instructional strategy on students' academic performance in biology among senior secondary schools in Zamfara state, Nigeria. International Journal of Advanced Academic and Educational Research, 13(7), 21-30.
27. UNESCO, (2023). Girls and women's education in science, technology, engineering, and mathematics (STEM). https:www.unseco.org/gender-equality/education/stem

28. West Africa Examination Council Chief Examiners' Report (2020). General Comment, Weakness/Remedies and Strength. https://waeconline.org.ng/elearning/Biology/Bio227mc.html.