ALSYSTECH
Journal of Education Technology

e-ISSN : 2988-442X
p-ISSN : 2988-4403

Index : Dimensions, Scilit, Crossref, Garuda, Semantic, Google Scholar, Base, etc

https://doi.org/10.58578/alsystech.v2i3.3766

INFERENCE ON COOPERATIVE LEARNING STRATEGY AND ACADEMIC ACHIEVEMENT OF PHYSICS STUDENTS IN GIREI LGA, ADAMAWA STATE

Danjuma Idi[1], Mathew Stephen[2], Ibrahim Michael[3]
[1]Federal University Wukari, Nigeria; [2]Kwararafa University Wukari, Nigeria
[3]Modibo Adama University, Yola, Nigeria
idanjumawatsaji@gmail.com; matsteve231@gmail.com

Article Info:

Submitted:	Revised:	Accepted:	Published:
Aug 10, 2024	Aug 23, 2024	Aug 26, 2024	Aug 29, 2024

Abstract

This study examined the effectiveness of cooperative learning strategy on secondary school students' academic achievement in physics. Guided by two research questions and three hypotheses, the study employed a quasi-experimental design and was conducted with a sample of 60 Senior Secondary School year two (SS2) physics students from Government Senior Secondary School Girei, Adamawa State. The Physics Achievement Test (PAT) was used to collect data, which were then analyzed using descriptive and inferential statistics. The results showed a significant mean score difference of 13.78333 ($p < 0.001$) favoring the cooperative learning group over the conventional group. Gender differences were significant in the conventional group (t-statistic = -20.696, $p < 0.001$), with males scoring higher, but not in the cooperative group (t-statistic = -35.658, $p = 0.425$). Thus, cooperative learning appears to reduce the gender gap in physics achievement. It is recommended that workshops be held to train teachers on effective cooperative learning strategies.

AlSysTech is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License

Keywords: Cooperative Learning; Academic Achievement; Science Education; Instructional Strategies; Student Outcomes

INTRODUCTION

Science education aims to equip individuals with the skills, abilities, and competencies necessary for personal development and societal contributions. Physics, a critical component of this education, examines the interactions between matter and energy under varying conditions. As a core subject in Senior Secondary School (SSS), physics plays a pivotal role in students' eligibility for admission into tertiary institutions for science-related programs. Despite its importance, academic performance in physics at the Senior Secondary School Certificate Examination (SSSCE) has been persistently poor and unsatisfactory (Kenni, 2020). Factors contributing to this poor performance include inadequate laboratory equipment (Mohzana et al., 2023), ineffective teaching methods (Ayogu, 2001), and the subject's inherent mathematical complexity.

To effectively teach and enhance understanding of complex physics concepts, adopting a conducive learning strategy is essential. Cooperative learning strategies, which foster collaborative interactions among students, have been recognized as beneficial in achieving educational objectives (Barreto et al, 2022). Cooperative learning involves students working in small, diverse groups to achieve shared goals, promoting positive interaction, mutual support, and individual accountability. According to Tinzmann (2013), cooperative classrooms exhibit four characteristics: altered teacher-student relationships, innovative instructional approaches, and a specific classroom composition. This teaching method encourages students to set goals, collaborate on tasks, monitor progress, and evaluate performance, while teachers facilitate these new roles.

Academic achievement, measured through tests, examinations, and assessments, reflects students' mastery of learning content (Pierre, 2010). Effective instructional strategies, such as cooperative learning, have the potential to improve academic performance and understanding of scientific concepts (Abramczyk & Jurkowski, 2020). Previous studies (Abramczyk & Jurkowski, 2020; Kenni, 2020; Mohzana et al., 2023) have demonstrated the impact of teaching methods on student achievement, highlighting the need for innovative approaches to address persistent underperformance in science subjects.

Science education research (York et al., 2021; De-Barros-Vidor et al., 2020; Stoeckel & Roehrig, 2021; Iwuanyanwu 2022; Cooper & Berry, 2020) has noted gender disparities in science participation, with girls often underrepresented in physics and other physical sciences (Lawal, 2009). This underscores the need for effective teaching strategies to improve student engagement and performance in these subjects. Given the ongoing challenges in science education, this study aims to investigate the effect of cooperative learning strategies on the academic achievement of physics students in Girei Local Government Area, Adamawa State. Specifically, it will evaluate: the differential effects of cooperative learning versus conventional teaching methods on physics achievement; and the impact of cooperative learning on male and female students' performance in physics.

Literature Review

Cooperative Learning (CL)

Onyejekwe (1996) highlights that for cooperative learning to be effective, careful planning is essential. Teachers need to ensure that students have sufficient background knowledge and that all group members, including those less academically inclined, are given equal opportunities to contribute. Nnaka (2006) defines cooperative learning as a strategy where small, diverse groups of students collaborate on tasks to enhance their understanding of a subject. Groups should be heterogeneous in abilities and backgrounds, with all members working together to achieve a common goal. Anaekwe (2006) distinguishes cooperative learning from simple group work by emphasizing the intentional, structured grouping of students based on specific criteria, rather than convenience or random selection. The teacher's role is to facilitate rather than dominate the discussion, allowing students to engage actively. Cooperative learning is a teaching method where diverse groups of students use various activities to deepen their understanding of a topic (Strauß & Rummel, 2020). It involves key elements like cognitive complexity and teamwork, fostering collaboration and group cohesion. This method has been effectively applied in many educational settings, including English Language Teaching (Lvmn, 2014), and can be used in various learning contexts.

Academic Achievement

Academic achievement reflects students' mastery of learning content and their success in completing academic tasks (Pierre, 2010). It is commonly assessed through tests, examinations, assignments, projects, and class exercises, often represented by grade scores.

To qualify for tertiary education, students typically need to achieve a credit pass in subjects such as physics. Achievement is enhanced by learner-centered instructional strategies, where students actively engage in their learning process (Doyle, 2023). Innovative methods, like think-pair-share, can further improve understanding and performance (Lom, 2012). Epunam (1999) defines academic achievement as the knowledge and skills acquired through both classroom and external study, also a student's performance in their subjects, determining their academic standing and future opportunities. Cortellazzo et al., (2021) broadens the concept to include performance across various academic and extracurricular areas, such as sports and communication skills.

Ohanyelu (2022) identifies variables such as parental socioeconomic status, supervision, and access to resources. Uche (2014) highlights that students from higher socioeconomic backgrounds often perform better due to better health, resources, and parental support. Parental motivation and educational background significantly impact a child's academic performance, with supportive parents fostering better achievements. The location of a student's home can affect performance, with urban students generally having access to better resources and a more conducive learning environment compared to their rural counterparts (Epunam, 1999; Uche, 2014). Additionally, access to well-equipped school libraries has been shown to correlate positively with academic achievement (Manyerere & Iwata, 2020).

Effect of Cooperative Learning and Student Achievement

Peklaf (2003) conducted a comprehensive study to investigate the impact of cooperative learning on Mathematics and Sloveno Language achievement among 370 fifth graders. Utilizing an experimental design, Peklaf created an experimental group that engaged in cooperative learning activities and a control group that received traditional instruction. The results revealed that cooperative learning significantly improved student achievement in both Mathematics and Sloveno Language, with a notable increase in mean scores. Furthermore, Peklaf found that cognitive styles played a crucial role in shaping student achievement within cooperative settings, whereas gender and ability did not exhibit significant interactions.

Ajaja and Eravwoke (2010) designed a rigorous study to assess the effects of cooperative learning on Junior Secondary School students' achievement in Integrated Science. Employing a 2×2 factorial, pretest-posttest control group design with 120

students, they examined the interactions between cooperative learning, ability, and gender. The findings indicated that students in the cooperative learning group achieved significantly higher scores than their counterparts in traditional classrooms, regardless of ability or gender. This suggests that cooperative learning can be an effective instructional strategy for promoting academic achievement in Integrated Science, with benefits accruing to students of varying abilities and genders.

Omeodu and Utuh (2018) conducted a quasi-experimental study to examine the effects of cooperative learning on secondary school physics students' understanding of radioactivity. They assigned students to either an experimental group receiving cooperative learning instruction or a control group receiving traditional instruction. The results showed that students taught with cooperative learning strategies demonstrated a better understanding of radioactivity concepts compared to those taught with traditional methods. Notably, the study highlighted the importance of using cooperative instructional strategies in science education, particularly for promoting gender equity in physics education.

Cámara-Zapata and Morales (2020) investigated the effect of cooperative learning and student characteristics on learning, persistence, and academic performance in an engineering physics course. Using a mixed-methods design, they collected data from 600 students and analyzed the impact of cooperative learning on learning gains, persistence, and academic performance. The findings revealed that cooperative learning significantly increased learning gains, persistence, and academic performance, with student characteristics such as prior education and community size influencing persistence.

Bozzi et al. (2021) demonstrated the effectiveness of integrated teaching methodologies combining peer learning, technology, and traditional lectures in large engineering classes. Utilizing a quasi-experimental design, they assigned over 600 engineering students to either an experimental group receiving integrated instruction or a control group receiving traditional lectures. The results showed that the experimental group outperformed the control group in learning outcomes, regardless of the difficulty of the physics topics addressed. This suggests that integrated teaching methodologies can be an effective way to promote academic achievement in large engineering classes.

Kurniawan et al. (2021) assessed students' attitudes towards physics through the application of inquiry and Jigsaw cooperative learning models. Using a mixed-methods design, they collected data from 55 students and analyzed the impact of cooperative

learning models on attitudes towards physics. The findings revealed that students had positive attitudes towards physics, with no significant differences between the two cooperative learning models. This suggests that both inquiry and Jigsaw cooperative learning models can be effective in promoting positive attitudes towards physics.

Chibueze and Okoye (2021) investigated the relative effectiveness of cooperative and inquiry learning methods on students' academic achievement and retention in Basic Electricity. Using a quasi-experimental design, they assigned 60 National Technical College students to either a cooperative learning group or an inquiry learning group. The results showed that cooperative learning was more effective than inquiry learning in facilitating academic achievement and retention in Basic Electricity. This suggests that cooperative learning can be a more effective instructional strategy for promoting acad

METHODS

Research Design

This study employed a quasi-experimental research design to establish a cause-and-effect relationship between teaching methods and student achievement. As random assignment of subjects was not possible, a non-equivalent groups design was used. According to Campbell and Stanley (1986), this design is appropriate when administrative or practical constraints prevent random assignment.

Area of the Study

The research was conducted at Government Senior Secondary School Girie, located in Girie Local Government Area, Adamawa State, Nigeria. This mixed-gender school serves both male and female students. Girei, situated on the Benue River, is a region with a predominantly agricultural economy. The study's location is relevant as it provides insight into the educational impacts of cooperative learning strategies in a specific socio-economic context.

Population of the Study

The study population included all Senior Secondary two (SS2) physics students at Government Senior Secondary School Girie during the 2021/2022 academic session. The total number of SS2 students enrolled in physics was 62. The students were divided into two classes: SS2A with 30 students and SS2B with 32 students. SS2 was chosen because the

curriculum topics (temperature and pressure) align with the SS2 syllabus and because these students would not be distracted by the Senior School Certificate Examination.

Sample and Sampling Techniques

A simple random sampling technique was used to select a sample of 60 students from the population. From the two classes (SS2A and SS2B), purposive sampling was employed to designate one class to the experimental group and the other to the control group. Each group consisted of 30 students. The sample can be represented as:

Sample size=n=60
Experimental group size=n_{exp}=30
Control group size=n_{ctrl}=30

Instrument for Data Collection

The Physics Achievement Test (PAT) was used to assess student performance. The PAT comprised 20 multiple-choice questions, each with four options (A, B, C, D) and one correct answer. The test was designed to measure the effectiveness of the teaching methods.

To validate the PAT, the following validation criteria were applied:

1. Content Validity: Ensured that the PAT covered all relevant topics.

2. Construct Validity: Ensured that the PAT accurately measures the students' physics knowledge.

Reliability of the Instrument

The reliability of the PAT was assessed using the test-retest method. The test was administered twice to a sample of two students who were not part of the main study. The reliability coefficient *r* was calculated using:

$$r = \frac{\mathrm{Cov}(X_1, X_2)}{\sigma_{X_1}\sigma_{X_2}} \quad (1)$$

where X_1 and X_2 are the test scores from the two administrations, and σ_{X_1} and σ_{X_2} are the standard deviations of the scores.

Treatment and Procedure

The teaching intervention lasted four weeks. The procedure was as follows:

1. Pre-Test: Administered to both groups to assess baseline knowledge.

2. Instruction: The experimental group was taught using cooperative learning strategies, while the control group was taught using conventional methods.

3. Post-Test: Administered to both groups after the teaching period.

The cooperative learning strategy involved dividing the experimental group into small groups of five students. Each group was led by a peer leader and engaged in collaborative learning activities. The control group studied individually without group interactions.

The effectiveness of the teaching methods was evaluated using the following equations:

i. Mean Score Calculation:

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} X_i \tag{2}$$

where $\bar{X}$ is the mean score, X_i represents individual test scores, and n is the number of students.

ii. Standard Deviation Calculation:

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X})^2} \tag{3}$$

where σ is the standard deviation, X_i represents individual test scores, and $\bar{X}$ is the mean score.

iii. Hypothesis Testing Using Student's t-Test:

To test the hypotheses, the following t-test formula was used:

$$t = \frac{\bar{X}_{\text{exp}} - \bar{X}_{\text{ctrl}}}{\sqrt{\frac{s^2_{\text{exp}}}{n_{\text{exp}}} + \frac{s^2_{\text{ctrl}}}{n_{\text{ctrl}}}}} \tag{4}$$

where: $\bar{X}_{exp}$ and $\bar{X}_{ctrl}$ are the mean scores of the experimental and control groups; s^2_{exp} and s^2_{ctrl} are the variances of the experimental and control groups; n_{exp} and n_{ctrl} are the sample sizes of the experimental and control groups, respectively.

Data Analysis

Data were analyzed using descriptive statistics, including mean and standard deviation, to address the research questions. The student's t-test was used to test the hypotheses, determining if there were statistically significant differences between the experimental and control groups. Results were presented according to the research questions and hypotheses.

RESULTS

Research Question One

What is the effect of cooperative learning strategy and conventional method in physics achievement?

Table 1: PAT Scores of Students taught using;

1a: **Cooperative Learning**

	First test scores	**Second test scores**
Mean	10.15	21.60
Mode	12.00	24.00
Standard Deviation	4.72	3.54
Range	18.00	12.00
Minimum	0.00	15.00
Maximum	18.00	27.00
Total score per group	304.50	648.00
Number of Students in a group	30.00	30.00

1b: **Conventional Learning**

	First test scores	**Second test scores**
Mean	9.45	10.45
Mode	12.00	12.00
Standard Deviation	5.40	6.30
Range	21.00	28.50

Minimum	0.00	0.00
Maximum	21.00	28.50
Total score per group	283.50	313.50
Number of Students in a group	30.00	30.00

Table 1 presents the results of a comparative study involving 60 students divided into two groups: a control group taught using conventional learning and an experimental group taught using cooperative learning. The study aimed to investigate the effectiveness of these instructional methods on student achievement in physics. Statistical tests were conducted at a 5% level of significance.

The results in Table 1a and 1b reveal that students taught using cooperative learning demonstrated higher mean achievement scores in all three tests, with scores of 10.15, 21.6, and 22.4, respectively. In contrast, students taught using conventional learning had lower mean scores of 9.45, 10.45, and 17.65, respectively. Notably, the average score of students taught using cooperative learning increased significantly across the three tests.

Further analysis of the results shows that the cooperative learning group had higher mean, mode, and standard deviation values compared to the conventional learning group. These findings suggest that cooperative learning is associated with better student performance and more consistent achievement. To determine if these differences are statistically significant, further testing is required to confirm whether the observed differences in performance between the two groups are due to the instructional methods used.

Test of Hypothesis 1

H_1: There is no significant difference in the test scores of students taught using cooperative learning instructional strategy and those taught using conventional teaching methods.

Table 2: Paired Samples Test on Performance by Learning Strategies

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Average Score - Learning Strategy	13.78333	3.63174	.46886	12.84515	14.72151	29.398	59	.000

Table 2 presents the results of a paired samples t-test, which examined the differential effects of cooperative learning and conventional learning strategies on students' average scores. The analysis yielded a statistically significant mean difference of 13.78333 ($p < 0.001$), indicating a substantial disparity in the average scores between the two groups. The 95% confidence interval (12.84515, 14.72151) provides a reliable estimate of the true mean difference, thereby bolstering the validity of the findings.

The t-statistic (29.398) and associated p-value (0.000) unequivocally indicate a statistically significant difference in the average scores between the cooperative learning and conventional learning groups. At a 5% level of significance, the null hypothesis is rejected, confirming that the observed difference in average scores is not attributable to chance.

The results unequivocally demonstrate that students taught using cooperative learning exhibited a significantly higher mean PAT score (16.8) compared to their counterparts taught using conventional learning (14.8). This finding suggests that cooperative learning is associated with enhanced student performance in physics, and the difference in mean scores is statistically significant.

Research Question Two

What is the effect of cooperative learning strategy on physics Achievement of male and female students?

Conventional Learning Strategies by Sex of the Students

Table 3: Scores for Conventional Learning Strategy by Sex of the Students

	N	Mean	Minimum	Maximum
Male	14	18.18	12.51	23.49
Female	16	15.42	11.01	22.50

Table 3 presents the summary statistics for the distribution of PAT scores by sex among students taught using the conventional learning strategy. A comparative analysis of the scores reveals notable differences in the performance of male and female students. The mean PAT score for male students (18.18) was significantly higher than that of their female counterparts (15.42). Furthermore, the minimum and maximum scores for male students

(12.51 and 23.49, respectively) exceeded those of female students (11.01 and 22.50, respectively).

The results suggest that male students outperformed female students in the conventional learning group, with higher mean, minimum, and maximum scores. This disparity warrants further investigation to determine the underlying factors contributing to the difference in performance. It is essential to consider the implications of these findings for instructional design and pedagogical practices, particularly in the context of conventional learning strategies. A subsequent analysis will examine the scores of students taught using cooperative learning to determine if similar patterns emerge.

Test of Hypothesis 2

H_2: There is no significant difference in the test scores of students taught using conventional learning instructional strategy and those taught using conventional teaching methods.

Table 4: Paired Samples Test for Conventional and Cooperative Learning Strategies by Sex

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Cooperative Learning	-17.58333	2.70084	.49310	-18.59184	-16.57482	-35.658	1	. 425
Conventional Learning	-11.93103	3.10450	.57649	-13.11192	-10.75015	-20.696	1	.000

Table 4 presents the results of a paired samples t-test examining the differences in PAT scores between male and female students taught using conventional and cooperative learning strategies. The analysis revealed a statistically significant difference in scores between male and female students in the conventional learning group, with a t-statistic of -20.696 ($p < 0.001$). This indicates that the average test score for male students taught using the conventional strategy was significantly higher than that of their female counterparts.

In contrast, the cooperative learning group exhibited a non-significant difference in scores between male and female students, with a t-statistic of -35.658 ($p = 0.425$). The

95% confidence interval for the difference in means (-18.59184, -16.57482) suggests that the true mean difference lies within this range.

These findings suggest that the conventional learning strategy may be associated with a significant gender gap in physics achievement, favoring male students. In contrast, the cooperative learning strategy appears to mitigate this gender gap, promoting more equitable learning outcomes. Further investigation is warranted to explore the underlying factors contributing to these differences.

Cooperative Learning Strategies by Sex of the Students

Table 5: Cooperative Learning by Sex of the Students

	N	Mean	Minimum	Maximum
Male	16	14.31	8.01	18.99
Female	14	15.36	8.49	21.00

The results in Table 5 indicating that female students performed slightly better than male students in the cooperative learning group, with mean PAT scores of 15.36 and 14.31, respectively. The similarity in minimum scores for both groups (8.01 for males and 8.49 for females) suggests that both groups had similar lower bounds of performance. However, the maximum score for female students (21.00) exceeded that of male students (18.99), indicating that female students had a greater range of scores and potentially more variability in their performance.

The difference in mean scores between male and female students (1.05) is relatively small compared to the overall range of scores, indicating that the gender difference in performance is not drastic. Nevertheless, it is crucial to acknowledge that these results are based on a relatively small sample size (N = 16 for males and N = 14 for females), which may limit the generalizability of the findings.

Test of Hypothesis 3

H_2: There is no significant difference in the test scores of male and female students taught using the cooperative learning strategy.

The calculated t-statistic of 35.658 and associated P-value of 0.425 indicate that there is no statistically significant difference in the PAT scores of male and female students taught physics using the cooperative learning strategy at a 0.05 level of significance. Since

the P-value (0.425) is greater than the chosen significance level (0.05), we fail to reject the null hypothesis, suggesting that the observed difference in mean scores between male and female students is not statistically significant. Therefore, we conclude that there is no significant difference in the PAT scores of male and female students taught physics using the cooperative learning strategy.

DISCUSSION

The study's findings revealed a significant difference in the mean achievement scores of students taught using the Cooperative Learning strategy compared to those taught using the conventional method. This difference can be attributed to the opportunities provided by Cooperative Learning for students to interact extensively with the learning material, fostering deeper understanding and increased academic achievement. The Cooperative Learning strategy also facilitated the development of scientific thought skills and scientific literacy among students, aligning with the findings of Omeodu and Utuh (2018). The results support the effectiveness of Cooperative Learning in promoting academic achievement, consistent with the findings of Ajika and Eravwoke (2010), Cámara-Zapata and Morales (2020), and Bozzi et al. (2021). However, the study's finding of an insignificant difference in PAT scores contradicts previous studies, suggesting that further research is needed to explore the nuances of Cooperative Learning's impact. The study's findings also align with Kurniawan et al. (2021), who found that cooperative learning models can promote positive attitudes towards physics. Additionally, the results support the effectiveness of Cooperative Learning in developing scientific thought skills and scientific literacy, consistent with the findings of Furquon (2015) and Adekunle (2015). Notably, the study found that the performance of students taught using Cooperative Learning did not depend on their sex, aligning with Ajika and Eravwoke's (2010) findings. This suggests that Cooperative Learning is an effective method for improving learning outcomes for both male and female students. Overall, the study's findings contribute to the growing body of evidence supporting the effectiveness of Cooperative Learning in promoting academic achievement and scientific literacy.

CONCLUSION

The findings of this study demonstrated that Cooperative Learning is a highly effective strategy for teaching and learning physics concepts. This approach not only enhances student engagement but also fosters a more interactive and collaborative learning environment. By adopting Cooperative Learning, physics teachers can encourage active student participation, promote student-to-student interaction, and empower learners to take ownership of their learning process. Ultimately, this study suggests that Cooperative Learning has the potential to revolutionize the teaching and learning of physics and other basic sciences, leading to improved academic outcomes and a more engaging educational experience for students.

Recommendations

Based on the findings of this study, the following recommendations are made:

i. Physics teachers should incorporate Cooperative Learning strategies into their teaching practices to promote meaningful learning and enhance student engagement.

ii. School administrators should organize regular workshops and seminars to provide physics teachers with training and support on effectively implementing Cooperative Learning strategies in their classrooms.

iii. Teacher training institutions should revise their curricula to include Cooperative Learning methodologies, emphasizing problem-solving skills and collaborative learning approaches, to ensure that future teachers are equipped to implement these strategies effectively.

iv. Encouraging inter-school collaboration and sharing of best practices in implementing Cooperative Learning strategies.

v. Providing resources and support for teachers to develop and share Cooperative Learning materials and activities.

REFERENCES

Abramczyk, A., & Jurkowski, S. (2020). Cooperative learning as an evidence-based teaching strategy: What teachers know, believe, and how they use it. *Journal of Education for Teaching*, *46*(3), 296-308.

Ajaja, P. O and Ochuko, U. E (2010). Effects of cooperative learning strategy on junior secondary school two (JS II) students' achievement in Integrated Science. *Electronic Journal of Science Education*, 14 (1): 1-15

Ayogu, Z. U. (2001). Enriching Science, Technical and Mathematics Education. 41st National Conference Proceedings of the Science Teachers Association of Nigeria. 396-399.

Barreto, D., Oyarzun, B., & Conklin, S. (2022). Integration of cooperative learning strategies in online settings. *E-Learning and Digital Media*, *19*(6), 574-594.

Bozzi, M., Raffaghelli, J. E., & Zani, M. (2021). Peer learning as a key component of an integrated teaching method: Overcoming the complexities of physics teaching in large size classes. *Education Sciences*, *11*(2), 67.

Cámara-Zapata, J. M., & Morales, D. (2020). Cooperative learning, student characteristics, and persistence: an experimental study in an engineering physics course. *European Journal of Engineering Education*, *45*(4), 565-577.

Chibueze, G. I., & Okoye, K. E. (2021). Relative effectiveness of cooperative and inquiry learning methods on students'academic achievement and retention in basic electricity. *Nau Journal of Technology and Vocational Education*, *6*(1), 208-218.

Cooper, G., & Berry, A. (2020). Demographic predictors of senior secondary participation in biology, physics, chemistry and earth/space sciences: students' access to cultural, social and science capital. *International Journal of Science Education*, *42*(1), 151-166.

Cortellazzo, L., Bonesso, S., Gerli, F., & Pizzi, C. (2021). Experiences that matter: Unraveling the link between extracurricular activities and emotional and social competencies. *Frontiers in Psychology*, *12*, 659526.

De-Barros-Vidor, C., Danielsson, A., Rezende, F., & Ostermann, F. (2020). What are the Problem Representations and Assumptions about Gender underlying Research on Gender in Physics and Physics Education?: A Systematic Literature Review. *Revista Brasileira de Pesquisa em Educação em Ciências*, *20*(u), 1133-1168.

Doyle, T. (2023). *Helping students learn in a learner-centered environment: A guide to facilitating learning in higher education*. Taylor & Francis.

Epunam, L. C. (1999). Influence of school environmental variables on academic performance as perceived by students. Unpublished M.Ed. Thesis. University of Nigeria, Nsukka.

Iwuanyanwu, P. N. (2022). Is science really for me? Gender differences in student attitudes toward science. *School Science and Mathematics*, *122*(5), 259-270.

Kenni, A. M. (2020). Analysis of Students' Performance in Chemistry in the West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) from 2015-2018. *International Journal of Research and Analytical Reviews*, *7*(1), 35-49.

Kurniawan, D. A., Sukarni, W., & Hoyi, R. (2021). Assessing Students' Attitudes towards Physics through the Application of Inquiry and Jigsaw Cooperative Learning Models in High Schools. *International Journal of Instruction*, *14*(4), 439-450.

Lawal, F. K. (2009). Effectiveness of a Conceptual Change in Situation Strategy in Remediating identified misconception in Genetics among Senior Secondary School

Students in Kano State. Unpublished PhD Dissertation presented to the Department of Education, A.B.U. Zaria.

Lom, B. (2012). Classroom activities: simple strategies to incorporate student-centered activities within undergraduate science lectures. *Journal of Undergraduate Neuroscience Education*, *11*(1), A64-A71.

Manyerere, J. J., & Iwata, J. J. (2020). The role of school libraries in promoting students' academic performance in Tanzania.

Mohzana, M., Murcahyanto, H., Fahrurrozi, M., & Supriadi, Y. N. (2023). Optimization of Management of Laboratory Facilities in the Process of Learning Science at High School. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 8226-8234.

Nnaka, C.V. (2006) Innovative strategies for effective teaching and learning of science, technology and mathematics (STM) in schools. Paper presented at the workshop by science teachers Association of Nigeria, Awka.

Ohanyelu, C. N. (2022). Family Background as an Indicator of Students' Academic Achievement in Science Subjects Among High School Students in Nigeria. *American journal of arts and education administration research*, *1*(1), 1-10.

Omeodu M. D. & Utuh B. N. (2018). Effects of Cooperative Learning Strategy on Secondary School Physics Students' Understanding of the Concept of Radioactivity, *International Journal of Education and Evaluation* 4(4), 37-58.

Onyejekwe, A.N. (1996) The differential effects of three teaching methods on senior secondary students' achievement and interest in history. Unpublished doctoral thesis, faculty of Education, University of Nigeria, Nsukka.

Peklaf C. (2003) Gender, Abilities, Cognitive Styles and Students' Achievement in Cooperative learning. Retrieved 0n 13/05/2021 from http://www.znanstveni.cmpiricinc.raziskoralni

Pierre, W.O. (2010). *Academic achievers: Whose definition?* Netherlands: Sense Publishers.

Stoeckel, M. R., & Roehrig, G. H. (2021). Gender differences in classroom experiences impacting self-efficacy in an AP Physics 1 classroom. *Physical Review Physics Education Research*, *17*(2), 020102.

Strauß, S., & Rummel, N. (2020). Promoting interaction in online distance education: designing, implementing and supporting collaborative learning. *Information and learning sciences*, *121*(5/6), 251-260.

Tinzmann, M. B. (2013). What is the Collaborative Classroom? http:/methodenpool.uni koeln.de/koopunterricht/TheCollaborativeClassroom.html.

Uche, J. P. (2014). The influence of socio-economic status of parents and home environment on the study habits and academic achievement of students". *Educational Research, 5* (9), 348-352.

York, A. M., Fink, A., Stoen, S. M., Walck-Shannon, E. M., Wally, C. M., Luo, J., ... & Frey, R. F. (2021). Gender inequity in individual participation within physics and science, technology, engineering, and math courses. *Physical Review Physics Education*