EFFICACY OF TWO MODES OF PROJECT-BASED TEACHING METHODS ON STUDENTS' INTEREST IN BASIC SCIENCE AND TECHNOLOGY: IMPLICATIONS FOR SCIENCE TEACHERS, EDUCATIONAL AND BUSINESS MANAGERS

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Abstract

This study examined the efficacy of two modes of project-based teaching methods (grouped and individualized) on students' interest in Basic Science and Technology, with gender as a moderating variable. The study was motivated by the persistent low interest and engagement of students in Basic Science, which is critical for scientific literacy and national development. A quasi-experimental design was employed, involving 76 secondary school students (34 males and 42 females) from selected schools. The Basic Science Interest Scale (BSIS) was used to collect pre-test and post-test data. Reliability of the instrument was established using Cronbach Alpha, which gave reliability coefficient of 0.84. Descriptive statistics of mean and standard deviation and analysis of covariance (ANCOVA) were used to analyze the data. Findings revealed that students taught using the Group Project-Based Teaching Method recorded significantly higher interest scores than those taught using the Individualized Project-Based Teaching Method; there was no significant difference in the mean interest scores of male and female students in Basic Science, although male students recorded slightly higher interest ratings than their female counterparts; the interaction effect of gender and teaching methods on students' interest in Basic Science was not significant. It recommends that science teachers adopt these methods, while educational and business managers provide resources and support to facilitate their implementation.

Keywords: Project-Based Teaching, Grouped Project, Individualised Project, Basic Science and Technology, Students' Interest, Gender

Introduction

Science education is widely recognized as a major driver of national development because it equips learners with knowledge, skills, and attitudes necessary for technological advancement, innovation, and economic growth. In Nigeria, Basic Science and Technology is a core subject at the basic education level and is designed to provide students with scientific literacy, problem-solving skills, creativity, and technological awareness (Federal Republic of Nigeria [FRN], 2014). The subject

integrates concepts from biology, chemistry, physics, and technology, serving as a foundation for further studies in science-related fields. Despite the importance of Basic Science and Technology, many Nigerian students continue to exhibit low interest and weak engagement in the subject. Research has shown that students often perceive science as abstract, difficult, and disconnected from real-life experiences, which negatively affects their motivation and attitude toward learning (Ogunleye, 2011; Okorie & Ezeh, 2016). One major contributor to this problem is the continued reliance on traditional teacher-centred instructional methods such as lecture and rote memorization, which limit students' participation and creativity (Yusuf & Afolabi, 2010). Interest is a crucial affective variable in learning, as it influences students' attention, persistence, and willingness to engage in academic tasks. According to Eccles and Wigfield (2002), students who show strong interest in a subject are more likely to invest effort and develop long-term engagement. In science education, students' interest has been identified as a strong predictor of achievement and career aspirations (Schiefele, 2009). Therefore, teaching strategies that stimulate learners' interest are essential for improving outcomes in Basic Science and Technology.

Project-based teaching has gained global recognition as an effective learner-centred approach that promotes active learning, creativity, and real-world problem solving (Thomas, 2000). It involves engaging students in meaningful projects that require inquiry, collaboration, critical thinking, and presentation of findings. Through this approach, learners actively construct knowledge by exploring real-life problems and applying scientific concepts (Bell, 2010). This method aligns with constructivist and social learning theories, which emphasize learning through experience and interaction (Vygotsky, 1978; Bandura, 1997). Project-based teaching can be implemented through different modes, notably grouped and individualised approaches. In the grouped project-based teaching method, students work in small teams to complete a project, share ideas, and solve problems collaboratively, thereby enhancing communication skills and social interaction (Johnson & Johnson, 2009). In contrast, the individualised project-based teaching method allows learners to work independently, promoting self-directed learning, responsibility, and creativity (Zimmerman, 2002).

Although both approaches are believed to enhance students' learning experiences, there is limited empirical evidence in Nigerian secondary schools on which mode is more effective in promoting students' interest in Basic Science and Technology. Some studies suggest that group projects improve motivation through peer interaction (Slavin, 2014), while others argue that individualised learning fosters deeper personal engagement (Schunk, 2012). This lack of consensus creates a gap in instructional practice and leaves teachers uncertain about the most effective mode to adopt.The implications of effective teaching strategies extend beyond the classroom. For science teachers, identifying the more effective mode of project-based teaching can enhance instructional delivery and classroom engagement. For educational managers, the findings can guide curriculum planning, teacher professional development, and policy decisions. Similarly, business managers benefit when schools produce learners who are innovative, collaborative, and problem-solving oriented skills required in the modern workforce (World Economic Forum, 2020). Against this background, this study examines the efficacy of grouped and individualised project-based teaching methods on students' interest in Basic Science and Technology. The study seeks to provide empirical evidence that will support science teachers, educational managers, and business managers in adopting teaching strategies that foster learners' interest, creativity, and readiness for future scientific and technological challenges.

In addition to comparing the efficacy of grouped and individualised project-based teaching methods, it is necessary to examine the role of gender in students' interest in Basic Science and Technology. This is because gender has historically been associated with differences in students' attitudes, participation, and interest in science-related subjects (Eccles & Wigfield, 2002; Ogunleye, 2011). In many societies, including Nigeria, cultural expectations and socialization patterns often shape how male and female students perceive science and technology, which can influence their level of

engagement. Although recent studies indicate that gender gaps in science interest are narrowing, findings remain inconsistent. Some studies report that male students show higher interest in science-related subjects, while others find no significant difference between male and female students, especially when learner-centred instructional strategies are used (Okorie & Ezeh, 2016; Olatoye & Aderogba, 2011). These conflicting findings make it necessary to further investigate gender as a moderating variable in instructional research. Including gender as a variable will provide a clearer understanding of how instructional strategies can be designed to promote equitable learning experiences. This will enable science teachers, educational managers, and business managers to adopt inclusive teaching practices that support all learners and contribute to balanced human capital development.

Purpose of the Study

The general purpose of this study is to determine the efficacy of two modes of project-based teaching methods on students' interest in basic science and technology: implications for science teachers, educational and business managers. Specifically, the study sought to determine the;

1. efficacy of grouped and individualized project-based teaching methods on students' interest in Basic Science;
2. influence of gender on students' interest in Basic Science;
3. interaction effect of teaching methods and gender on students' interest in Basic Science.

Research Questions

The following research questions guided the study;

1. What is the mean interest rating scores of students taught Basic Science using grouped project-based teaching method and those taught using individualised project- based teaching method?
2. What is the influence of gender on students' mean interest rating scores in Basic Science?
3. What is the interaction effect of teaching methods and gender on students' interest in Basic Science?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the mean interest ratings of students' taught Basic Science using grouped project-based method (GPBM) and those taught using individualized project-based method (IPBM).
2. There is no significant influence of gender on the mean interest ratings of Basic Science students.
3. There is no significant interaction effect of teaching methods and gender on students' interest in Basic Science.

Methods

The study adopted a quasi-experimental design, specifically a pre-test, post-test non-equivalent control group design. This design was chosen because it allows for the comparison of the efficacy of two instructional strategies (grouped and individualised project-based teaching methods) on students' interest in Basic Science and Technology, while controlling for initial differences in interest levels through pre-test measures. Quasi-experimental designs are suitable in educational settings where random assignment of participants is not feasible due to intact classes (Creswell & Creswell, 2018).

The population of the study comprised 2,279 Junior Secondary School Two (JSS2) students offering Basic Science in Nsukka Local Government Area of Enugu State, made up of 1,092 males and 1,187 females. A total of 76 JSS II students (34 male and 42 female students) were used for the study. The sample was gotten through multistage sampling procedure.

The instrument used for data collection was the Basic Science Interest Scale (BSIS), developed by the researchers and validated by experts in Science Education. The scale measured students' interest in Basic Science and Technology across cognitive, affective, and behavioural domains. The BSIS consisted of 20 items rated on a four-point Likert scale (Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1). A trial test was conducted to determine the reliability of the instrument, yielding a Cronbach's alpha coefficient of 0.84, indicating high internal consistency.

Procedure for Data Collection

Permission was obtained from the school authorities before the commencement of the experiment. Pre-tests were administered to both groups to determine baseline interest levels. The intervention lasted for six weeks, during which one group was taught using the grouped project-based teaching method, while the other group used the individualised project-based teaching method. During the intervention, students in the grouped mode collaborated in small teams to complete assigned projects, while students in the individualised mode worked independently on similar projects. After the intervention, the post-test was administered to both groups using the BSIS.

Descriptive statistics, including mean and standard deviation, were used to summarize students' pre-test and post-test interest scores. Analysis of covariance (ANCOVA) was used to test the formulated hypotheses. All the hypotheses were tested at a 0.05 level of significance.

Result

Research Question One

What are the mean interest rating scores of students taught Basic Science using group project and individualized project-based teaching methods?

Table 1: Mean and Standard Deviation (SD) interest scores of students taught Basic Science using group project and individualized project-based teaching methods

Methods	N	Pre-test		Post-test		Mean Gain	Mean Gain Diff
		Mean	SD	Mean	SD		
GPBTM	36	38.48	5.26	70.43	7.54	31.95	15.88
IPBTM	40	38.16	7.53	54.23	10.69	16.07	

Results in Table 1 revealed the mean interest and standard deviation scores of students taught Basic Science using group project-based teaching method (GPBTM) and Individualized project-based teaching method (IPBTM). The result shows that the GPBTM group had mean interest score of 38.48 with standard deviation of 5.26 at pretest and mean interest score of 70.43 with standard deviation of 7.54 at posttest, recording a mean gain of 31.95. While the group taught basic science using IPBTM had mean interest score of 38.16 with standard deviation of 7.53 at pretest and a mean interest score of 54.23 with a standard deviation of 10.69 at posttest, recording a mean gain of 16.07. Also, the results revealed that the pretest standard deviations for the two groups were smaller than the posttest standard deviations. This means that the pretest scores of the respondents were more homogeneous in each case and clustered around the means than the posttest scores. For each of the groups, the posttest mean scores were greater than the pretest mean scores, with the GPBTM group having a higher mean gain. This is an indication that GPBTM enhances students' interest in basic science better than IPBTM.

Hypothesis One

There is no significant difference in the mean interest ratings of students taught Basic Science using group project-based method (GPBM) and those taught using individualized project-based method (IPBM).

Table 2: Analysis of Covariance on the mean interest scores of students taught basic science with GPBTM and IPBTM

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	361.745[a]	2	180.872	3.583	.037	.155
Intercept	3897.857	1	3897.857	77.223	.000	.664
Pretest	1.550	1	1.550	.031	.862	.001
Methods	5605.918	1	5605.918	65.344	.000	.443
Gender	358.294	1	358.294	7.098	.081	.154
Method * Gender	465.679	1	465.679	11.351	.146	.189
Error	1968.541	73	50.475			
Total	210658.000	76				
Corrected Total	2330.286	75				

Result in Table 2 shows that the F-ratio is 65.344 with 1 degree of freedom and p-value of .000. Thus, the null hypothesis of no significant difference was rejected because the exact probability value of .000 is less than the level of significance set at .05. Therefore, the researchers conclude that there is a significant difference in the mean interest rating scores of students taught Basic Science using GPBTM and IPBTM.

Research Question Two

What is the influence of gender on students' mean interest ratings in Basic Science?

Table 3: Mean and standard deviation of male and female students in Basic Science

Gender	N	Pre-test		Post-test		Mean Gain	Mean Gain Diff
		Mean	SD	Mean	SD		
Male	34	39.32	5.54	68.84	7.54	29.52	
Female	42	38.81	6.34	67.59	10.69	28.78	.74

The pre-test results show that male students had a mean score of 39.32 (SD = 5.54), while female students had a closely related mean score of 38.81 (SD = 6.34). This indicates that both groups were almost at the same level of achievement in Basic Science before the treatment, suggesting that the students had comparable entry knowledge regardless of gender. After the treatment, the post-test results reveal that male students recorded a mean score of 68.84 (SD = 7.54), while female students had a mean score of 67.59 (SD = 10.69). This shows that both male and female students improved substantially in their achievement after the intervention. In terms of learning gains, male students achieved a mean gain of 29.52, whereas female students recorded a mean gain of 28.78. The

difference in mean gain between male and female students is 0.74, which is very small. This suggests that the instructional strategy used was almost equally effective for both male and female students.

Hypothesis Two

There is no significant influence of gender on the mean interest ratings of Basic Science students.

Result in Table 2 was also used to test hypothesis two. Result in Table 2 shows that the F-ratio is 7.098 with 1 degree of freedom and a 0.081 significant level. Since the associated alpha level of 0.081 is greater than the chosen p-value of .05 (P<0.05), the null hypothesis was accepted. Thus, the researchers conclude that there is no significant difference in the mean interest scores of male and female students in Basic Science.

Research Question Three

What is the interaction effect of teaching methods and gender on students' interest in Basic Science?

Table 4: The mean and Standard Deviation (SD) interest scores of male and female students taught Basic Science using GPBTM and IPBT

Teaching Methods	Gender	N	Pre-test		Post-test	
			Mean	SD	Mean	SD
GPBTM	Male	16	38.30	5.57	73.50	8.23
	Female	20	38.64	4.99	67.64	5.64
IPBTM	Male	18	38.16	8.37	57.26	9.24
	Female	22	38.17	6.98	51.83	7.62

The result presented in Table 4 above shows the mean and standard deviation interest scores of male and female students taught basic science using GPBTM and IPBTM. For GPBTM, the result shows that the male students had a mean interest rating of 38.30, SD = 5.57 at pretest and a mean interest rating of 73.50, SD = 8.28 at posttest, recording a mean gain of 35.20. On the other hand, the female students had a mean interest rating of 38.64, SD = 4.99 at pretest and a mean interest rating of 67.64, SD = 5.64 at posttest, recording a mean gain of 29.00. Conclusively, the result shows that male students taught basic science using a group project-based method demonstrated higher interest than their female counterparts.

For the individualized project-based teaching method, male students had a mean interest rating of 38.16, SD = 8.37 at pretest and a mean interest rating of 57.26, SD = 9.24 at posttest, recording a mean gain of 19.10. While their female counterparts had a mean interest rating of 38.17, SD = 6.98 at pretest and a mean interest rating of 51.83, SD = 7.62 at posttest, recording a mean gain of 13.66. This shows that male students demonstrated higher interest when taught basic science with IPBTM than their female counterparts. Conclusively, students taught with GPBTM outperformed those in IPBTM, with both male and female students in GPBTM having higher interest scores than their counterparts in IPBTM.

Hypothesis Three

There is no significant interaction effect of teaching methods and gender on students' interest in Basic Science.

The analysis in Table 2 was also used to test hypothesis three. The Table shows that the probability value of .146 associated with method and gender is greater than the 0.05 level of significance (F = 11.351, p =.146 > 0.05). Thus, the null hypothesis of no significant interaction effect of gender and

teaching methods on students' mean interest scores in Basic Science is upheld. The researcher, therefore, concludes that the interaction effect of gender and teaching methods on students' interest in Basic Science was not significant. The interaction effect was also interpreted using the screen plot shown in Figure 1 below.

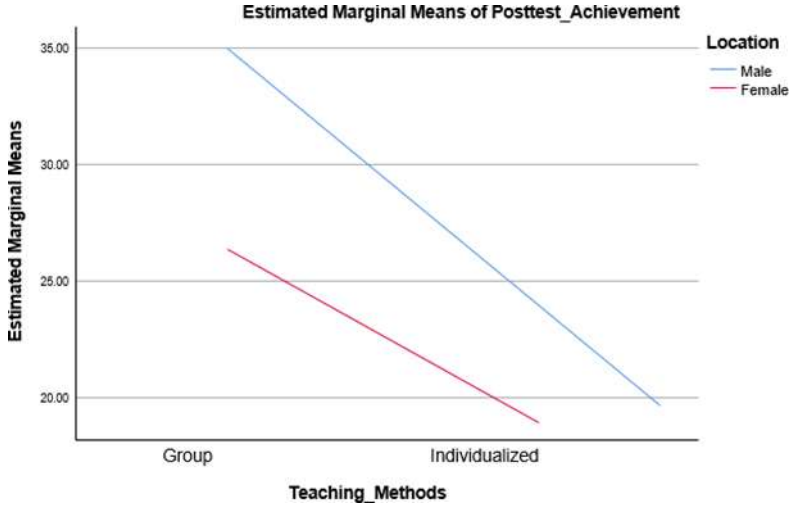

Figure 1: Graph of the interaction effect of gender and teaching methods on students' interest in Basic Science.

The screen plot in Figure 1 shows that there is no interaction effect of gender and teaching methods on students' interest in Basic Science. This is indicated by the separate lines for the male and female students' interest in Basic Science in the respective teaching methods.

Discussion of Findings

Effects of Grouped Project-based teaching methods and Individualized Project-based teaching methods on Students' Interest in Basic Science

The findings revealed that students taught using the Group Project-Based Teaching Method recorded significantly higher interest scores than those taught using the Individualized Project-Based Teaching Method. Although both groups improved from pretest to posttest, the GPBTM group showed a much greater increase in interest.This improvement may be attributed to the interactive and collaborative learning environment created by GPBTM, where students share ideas, ask questions, and engage actively in tasks. Group work reduces learning anxiety and boosts motivation because students feel supported by peers. This finding aligns with Ezeudu and Obi (2019) who reported that group-based learning significantly increases students' interest in science due to peer interaction. It is also consistent with Belland et al. (2017) who found that collaborative project-based tasks improve students' engagement and sustained interest in classroom learning. Conversely, while the individualized approach enhanced interest, its impact was comparatively lower. This is probably because some students may struggle with motivation or feel isolated when required to work entirely on their own. This is supported by Nwankwo and Eze (2020), who observed that individualized tasks may overwhelm learners who lack self-regulation. Similarly, Karatas and Cagiltay (2017) noted that individualized project work may reduce enthusiasm for students who prefer collaborative learning.

Influence of Gender on Students' Interest in Basic Science

The finding of this study revealed that there is no significant difference in the mean interest scores of male and female students in Basic Science, although male students recorded slightly higher interest ratings than their female counterparts. This result implies that gender does not significantly influence students' interest in Basic Science when exposed to the same instructional conditions. Similar outcomes have been reported in science education research, where gender differences in interest tend

to diminish when learners are taught using interactive and student-centred approaches (Ogunleye, 2011; Okorie & Ezeh, 2016). The slight difference observed in favour of male students may be attributed to traditional social and cultural stereotypes that portray science-related subjects as male-oriented. Such perceptions can influence students' attitudes and career aspirations (Eccles & Wigfield, 2002). However, the non-significant result in this study suggests that these stereotypes are gradually weakening, especially when classroom environments are supportive and inclusive.

This finding also indicates that the instructional strategy adopted in the study was gender-sensitive and motivating to both male and female students. Research shows that learner-centred strategies enhance students' interest and reduce gender gaps in science learning (Achor, Imoko, & Uloko, 2009; Yusuf & Afolabi, 2010). When students actively participate and see the relevance of learning activities, their interest becomes less dependent on gender. Furthermore, the result supports social learning perspectives. Vygotsky's social constructivist theory emphasizes that learning and interest are shaped by social interaction and shared classroom experiences (Vygotsky, 1978). Likewise, Bandura's social cognitive theory suggests that interest is developed through environmental influences, modelling, and self-efficacy rather than biological gender differences (Bandura, 1997). The finding is consistent with earlier studies that found no significant gender difference in students' interest in science when effective instructional methods were used (Olatoye & Aderogba, 2011; Okeke, 2014). However, it contrasts with some earlier research that reported higher interest among male students under traditional teaching methods (Onah & Ugwu, 2010). These differences may be due to changes in teaching practices and increasing awareness of gender equity in education.

Interaction effect of teaching methods and gender on students' interest in Basic Science

The findings of the study revealed that the interaction effect of gender and teaching methods on students' interest in Basic Science was not significant. This means that the level of interest shown by male and female students did not differ based on whether they were taught using the Group Project-Based Teaching Method (GPBTM) or the Individualized Project-Based Teaching Method (IPBTM). This outcome suggests that both methods were equally engaging, motivating, and stimulating for learners irrespective of gender. The hands-on, activity-oriented nature of both project-based approaches likely provided equal opportunities for participation, curiosity, and exploration, thereby removing social or psychological factors that usually create interest differences between boys and girls. This finding is supported by Wiggins (2017) who reported that project-based learning enhances students' interest without gender bias, as both males and females are naturally drawn to real-life, interactive learning tasks. Similarly, Ezenwosu and Ibe (2020) found that when boys and girls learn under the same innovative and participatory instructional conditions, their level of interest in science becomes similar because such methods minimize the influence of gender stereotypes and promote equal involvement.

Conclusion

Based on the findings, this study concludes that the Group Project-Based Teaching Method is more effective than the Individualized Project-Based Teaching Method in improving students' interest in Basic Science. GPBTM created a collaborative classroom environment that enhanced participation, motivation, and understanding of Basic Science concepts. The study further concludes that gender does not significantly influence students' interest in Basic Science. In addition, there was no interaction effect of teaching method and gender on students' interest in Basic Science, indicating that these methods work effectively for both genders.

Recommendation

The following recommendations were made based on the findings:

1. Teachers should adopt the Group Project-Based teaching method regularly to enhance interest and achievement in Basic Science.

2. Schools and curriculum bodies should incorporate structured group project-based tasks into Basic Science lessons.
3. Workshops should be organized to train teachers on how to effectively implement both group and individualized project-based methods.
4. Gender-inclusive strategies should be encouraged to ensure both boys and girls participate fully in project activities.

Implications for Science Teachers

The findings of this study imply that project-based teaching methods, whether implemented in grouped or individualised modes, are effective in enhancing students' interest in Basic Science and Technology. Science teachers should therefore move beyond traditional lecture-based approaches and adopt project-based strategies that actively involve students in real-life problem-solving tasks. By engaging learners in meaningful projects, teachers can make science concepts more concrete, relevant, and interesting.

Teachers are encouraged to use both grouped and individualised project approaches strategically, depending on lesson objectives and classroom conditions. Grouped projects can be used to promote collaboration, communication, and peer learning, while individualised projects can be employed to develop students' creativity, independence, and self-regulation skills. Since gender was found not to significantly influence students' interest, teachers should ensure that classroom activities are inclusive and encourage equal participation of both male and female students.

Furthermore, science teachers should receive continuous professional development on how to design, implement, and assess project-based learning activities. This will enable them to effectively manage classroom projects, guide students' inquiry processes, and evaluate both group and individual performance.

Implications for Educational Managers

For educational managers such as principals, school administrators, curriculum planners, and education policymakers, the results highlight the need to support learner-centred instructional approaches in schools. Educational managers should create policies that encourage the use of project-based teaching methods by providing adequate instructional resources, laboratories, and technological tools.

School administrators should organize regular workshops and in-service training programmes to equip teachers with the skills needed to implement project-based learning effectively. In addition, curriculum developers should integrate project-based activities into the Basic Science and Technology curriculum to ensure that learning is aligned with real-world applications.

Educational managers should also ensure that class sizes, assessment practices, and school schedules are structured in ways that support both grouped and individualised project-based learning. This will promote a more engaging and equitable learning environment for all students.

Implications for Business Managers

The findings of this study also have implications for business managers and industry stakeholders. Project-based learning helps students develop essential skills such as problem-solving, creativity, teamwork, communication, and self-direction, which are highly valued in the modern workplace. Business managers can therefore benefit from a future workforce that is better prepared for innovation and entrepreneurship.

Business organizations should consider partnering with schools to support project-based learning through sponsorships, mentorship programmes, provision of materials, and real-world project challenges. Such collaborations can help bridge the gap between classroom learning and industry needs, ensuring that students acquire practical skills relevant to the labour market. By supporting

education systems that emphasize project-based learning, business managers contribute to human capital development and long-term economic growth.

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