

INQUIRY-BASED FLIPPED CLASSROOM, GUIDED INQUIRY AND BASIC SCIENCE INTEREST OF JSS II STUDENTS WITH DIFFERENT VARK LEARNING STYLES IN YOLA EDUCATION ZONE, ADAMAWA STATE

Audu Umoru Danjuma, PhD¹, Simon Pannan Danlami, PhD², Blessing Okechukwu, PhD³, Charity Dominion Danjuma⁴ & Adamu Zakariya⁵

¹Department of Integrated Science, School for Secondary Education (Science Programmes), Federal College of Education, Yola, Adamawa State

²Model Government Girls Secondary School, Kwandare, Nasarawa State

³Department of Science Education, University of Nigeria, Nsukka, Enugu State

⁴c/o Department of Integrated Science, School for Secondary Education (Science Programmes), Federal College of Education, Yola, Adamawa State

⁵Department of Physics, School for Secondary Education (Science Programmes), Federal College of Education, Yola, Adamawa State

dadominion@fceyola.edu.ng¹; Pannansimon01@gmail.com²

ARTICLE INFO

Article No.: 0648

Accepted Date: 19/09/2026

Published Date: 18/10/2026

Type: Research

ABSTRACT

This study investigated the effects of inquiry-based flipped classroom and guided inquiry strategies on the interest of JSS 2 students with different learning styles in Basic Science in Yola Education Zone, Adamawa State. Two research questions and three hypotheses guided the study, which adopted a quasi-experimental pretest-posttest non-equivalent group design. The population comprised 21,334 JSS 2 students in public junior secondary schools in the zone. The sample was 393 students (198 males and 195 females) in intact classes from two coeducational schools purposively selected from two local government areas. Data were collected with the VARK learning style questionnaire (version 8.01) and the Basic Science Interest Inventory (Cronbach's alpha = .96) before and after a three-week treatment. The research questions were answered with means and standard deviations, and the hypotheses were tested at the .05 level of significance using analysis of covariance (ANCOVA). Students taught with the inquiry-based flipped classroom strategy had significantly higher interest than those taught with guided inquiry, $F(1, 384) = 14.69$, $p < .001$, partial $\eta^2 = .037$. Learning style had no significant effect on interest, $F(3, 384) = 0.60$, $p = .614$, and the interaction between strategy and learning style was not significant, $F(3, 384) = 1.47$, $p = .222$. It was recommended that Basic Science teachers adopt the inquiry-based flipped classroom strategy and that school administrators provide adequate multimedia resources and train teachers to use them.

Keywords: inquiry-based flipped classroom, guided inquiry, interest, learning styles, VARK model, basic science

Introduction

Basic Science is an integrated science course concerned with the study of natural phenomena. It enables students to understand science concepts, principles, theories and laws which are further elaborated in the core science. Adegbola and Adeleke (2023) maintain that Basic Science exposes students to scientific activities. Olamoyegun (2023) described basic science as the fundamental principles, theories and concepts that underpin scientific knowledge and lay the groundwork for applied science and technological advancement. The Basic Science curriculum aims to enable learners to develop interest in science, acquire basic scientific knowledge and skills, apply them to meet societal needs, take advantage of the career opportunities that science offers, and prepare for further studies (Adegbola and Adeleke, (2023)). Furthermore, Basic Science is aimed at enabling the student who is exposed to it to acquire the specific science process skills such as observing, organizing information acquired, generalizing on the basis of acquired information, predicting as a result of generalization and designing experiment to check predictions. Despite these objectives, studies report low interest among students in Basic Science (Abidoye & Abidoye, 2023), which the authors identified as a major source of anxiety for students.

Interest is a psychological construct that has attracted the attention of educational researchers. Nwuba et al. (2023) defined it as the attraction that compels a child to respond to a particular stimulus, or the feeling an individual has towards an object or activity. A learner is therefore likely to attend to a lesson only when the instruction holds his or her interest. Interest sustains concentration, purpose and commitment to learning and encourages cooperation with the teacher, which makes it fundamental to acquiring the knowledge, skills, values and attitudes that the curriculum seeks to develop. According to Ogunjimi and Gbadeyanka (2023), teachers can foster interest by identifying and meeting students' needs, acknowledging their successes however small, making the classroom student-friendly so that learning becomes interesting and fun, and respecting students' views, which builds their confidence. Aliyu et al. (2023) observed that students' curiosity and interest show in their performance and attributed this to the efforts of instructors during instruction.

Interest and achievement in Basic Science are influenced by several factors, including the instructional approach adopted by the teacher (Olaoye and Awogbeja, (2023)). Interest has often been examined in isolation, and limited attention appears to have been paid to how it interacts with other factors to influence learning outcomes. Understanding these interactions could give a fuller picture of the motivational processes underlying learning and inform interventions tailored to individual students' needs.

Learning styles are the different ways in which people interpret, organise and represent information. Krishan and Al-rsa'i (2023) described them as individual learning techniques that operate within the environment to help a person obtain, process and interpret information, experiences and desirable skills. Cam et al (2022) defined them as a group of characteristics, attitudes and behaviours that define one's way of learning and stressed that they reflect the preferred way in which a student perceives, processes, comprehends and retains information. Learning style is regarded as an important consideration in designing instruction, and it is commonly assumed that instruction consistent with students' learning styles makes delivery and mastery of content and skills more satisfactory and motivating. According to Cam et al, (2022), a learning style does not preclude that individuals can learn in multiple ways and using various tools, rather it indicates that a preferred learning method exists by which information is attained,

reflected upon and understood. It is therefore a combination of variables, which contribute to learning each in its way and all working together as a unit.

The inquiry-based flipped classroom is a student-centred approach in which learners use technological media for learning outside the classroom, while interactive and communicative learning takes place inside it. It therefore has two parts: interactive learning activities during lessons and computer-based individual learning outside lessons (Turan, 2023). The teacher typically records videos of concepts and processes, which students watch at home before class as homework (Alqawasmi et al., 2023). George and Osuafor (2023) reported that students understood topics better when inquiry learning was incorporated into flipped classes, and that exploratory learning through guided inquiry-based activities engaged students at a deeper level, increased their curiosity and developed their higher-order thinking skills. Also, Uzoma-Nwogu and Nwogu (2023) explained that in the inquiry-based flipped classroom learning approach, what used to be homework is now done in the classroom, after students have extensively gone through instructional content at home. Instructional contents are mostly packaged as easily playable videos commercially produced, obtained via open educational resource or directly (locally) produced by instructors. One of the advantages of the flipped classroom instructional approach according to Nwoke, et al, (2023) is that students have the opportunity to use class time to apply what they have learnt from the videos, which allow teachers to accurately assess whether or not students understand the content for the course and use various formative technique to assess understanding. Teachers have the ability to correct misconceptions before a summative examination occurs.

Guided inquiry is a student-centred, activity-oriented approach of inductive inquiry (Ogunjimi & Gbadeyanka, 2023). Students discover concepts or principles through inquiry, and the teacher engages them in one or more inquiry-based activities during class to help them understand the concepts. The approach is reported to increase students' interest, confidence, innovativeness and problem-solving ability and, consequently, to improve achievement in both theory and practice. Its interactive activities are also expected to address differences in learning styles and to bring variety to teaching and learning in Basic Science (Assem et al., 2024). Students gain new experience through guidelines provided by the teacher, usually in the form of questions that lead them to the expected solution. They investigate teacher-formulated questions and procedures and later determine the processes and conclusions (Bhakti et al (2023)). Because the teacher supplies the questions and is likely to know what answers to expect, the teacher's role is important: providing hints or feedback and posing further questions to lead students in the right direction. Guided inquiry also help student to engage in relatively sophisticated mental processes like formulating problems for investigation, formulating hypotheses, designing experiments, synthesizing knowledge, possessing scientific attitudes etc (Smida et al, 2024). According to Ogunjimi & Gbadeyanka (2023) guided inquiry approach of teaching promotes students active participation in the learning process. It increases students' ability to analyze, synthesize, evaluate and relate the intended learning concepts to multiple disciplines and everyday life, thereby making the materials more relevant to students.

Low interest in Basic Science has often been linked to teacher-centred instruction that leaves little room for active student participation. The inquiry-based flipped classroom and guided inquiry strategies have each been proposed as remedies, but few studies compare them directly. Fewer still examine whether their relative effectiveness depends on learners' learning styles as characterised by the VARK model, so it remains unclear whether one strategy works for all learners or only for certain groups. This study therefore investigated the effects of inquiry-

based flipped classroom and guided inquiry strategies on the interest of JSS 2 students with different learning styles in Basic Science.

Purpose of the Study

The main purpose of this study was to investigate the effects of inquiry-based flipped classroom and guided inquiry instructional strategies on the interest of students with different learning styles in Basic Science in junior secondary schools in Yola Education Zone, Adamawa State. Specifically, the study sought to determine:

1. the effect of inquiry-based flipped classroom and guided inquiry instructional strategies on students' interest in Basic Science;
2. the influence of learning styles on students' interest in Basic Science; and
3. the interaction effect of instructional strategy and learning style on students' interest in Basic Science.

Research Questions

The following research questions guided the study:

1. What are the mean interest scores of students taught Basic Science using the inquiry-based flipped classroom and guided inquiry instructional strategies?
2. What are the mean interest scores of students with visual, aural, read/write and kinaesthetic learning styles in Basic Science?

Hypotheses

The following null hypotheses were tested at the .05 level of significance:

Ho₁: There is no significant difference in the mean interest scores of students taught Basic Science using inquiry-based flipped classroom and guided inquiry instructional strategies.

Ho₂: There is no significant difference in the mean interest scores of students with different learning styles in Basic Science.

Ho₃: There is no significant interaction effect of instructional strategy and learning style on students' interest in Basic Science

Methods

Research Design

The study adopted a quasi-experimental pretest-posttest non-equivalent group design. The design was appropriate because intact classes, rather than individual participants, are assigned to treatment conditions (Nworgu, 2015).

Population and Sample

The study was conducted in public coeducational junior secondary schools in Yola Education Zone, Adamawa State, Nigeria. The population comprised 21,334 JSS 2 students offering Basic Science in all public junior secondary schools in the zone. The sample consisted of 393 students (198 males and 195 females) in intact classes from two coeducational schools, which were purposively selected from two local government areas in the zone.

Instruments

Two instruments were used: the adopted VARK learning style questionnaire (version 8.01), which has 16 items, and an adapted Basic Science Interest Inventory. The inventory had two sections. Section A collected demographic data, including gender and school name. Section B contained 24 items measuring students' interest in Basic Science on a four-point Likert scale. A student's score on the scale indicated the level of his or her interest in Basic Science, and these scores were used to compute the mean interest score of each group.

Validity and Reliability

The adapted Basic Science Interest Inventory was face- and construct-validated by experts in the Department of Science Education, Faculty of Education, University of Nigeria, Nsukka. Its internal consistency was determined with Cronbach's alpha, which yielded a reliability index of .96.

Procedure

The regular Basic Science teachers of the sampled schools served as research assistants. The Basic Science Interest Inventory was administered to both experimental groups before and after the treatment, which lasted three weeks.

Data Analysis

The scores were collated. Means and standard deviations were used to answer the research questions, and the hypotheses were tested at the .05 level of significance using analysis of covariance (ANCOVA), with the pretest interest score as the covariate.

Results

The results are presented in line with the research questions and the null hypotheses that guided the study.

Research Question 1: What are the mean interest scores of students taught Basic Science using the inquiry-based flipped classroom and guided inquiry instructional strategies?

Table 1: Mean and Standard Deviation of Basic Science Interest Scores by Instructional Strategy

Strategy	<i>N</i>	Pretest <i>M</i>	Pretest <i>SD</i>	Posttest <i>M</i>	Posttest <i>SD</i>	Mean gain
Inquiry-based flipped classroom (IBFC)	180	47.80	13.06	59.95	7.52	12.15
Guided inquiry (GI)	213	47.08	13.06	56.91	8.85	9.83

Note. *M* = mean; *SD* = standard deviation.

Table 1 shows that the pretest mean interest scores of the IBFC group ($M = 47.80$, $SD = 13.06$) and the GI group ($M = 47.08$, $SD = 13.06$) were almost equal, which indicates that the two groups had similar levels of interest before the treatment. At posttest, the IBFC group had a mean of 59.95 ($SD = 7.52$), a gain of 12.15, while the GI group had a mean of 56.91 ($SD = 8.85$), a gain of 9.83. The posttest standard deviations were smaller than the pretest standard deviations, which shows that scores became less spread out. The larger mean gain of the IBFC group indicates a greater increase in interest than that of the GI group.

Research Question 2: What are the mean interest scores of students with visual, aural, read/write and kinaesthetic learning styles in Basic Science?

Table 2: Mean and Standard Deviation of Basic Science Interest Scores by Learning Style

Learning style	<i>N</i>	Pretest <i>M</i>	Pretest <i>SD</i>	Posttest <i>M</i>	Posttest <i>SD</i>	Mean gain
Visual	68	48.32	10.55	57.13	7.88	8.81
Aural	112	46.46	13.81	58.75	9.04	12.29
Read/write	83	47.48	13.36	58.77	8.17	11.29
Kinaesthetic	130	47.70	13.44	58.23	8.25	10.53

Note. *M* = mean; *SD* = standard deviation.

Table 2 shows that pretest means ranged from 46.46 to 48.32 and posttest means from 57.13 to 58.77 across the four learning styles. Mean gains ranged from 8.81 for visual learners to 12.29 for aural learners. Aural and read/write learners had slightly larger gains than the other groups, although the ANCOVA in Table 3 shows that the differences were not significant.

H₀₁: There is no significant difference in the mean interest scores of students taught Basic Science using inquiry-based flipped classroom and guided inquiry instructional strategies.

Table 3: ANCOVA of Students' Posttest Interest Scores by Instructional Strategy and Learning Style

Source	SS	df	MS	F	p	Partial η^2
Corrected model	1,409.82	8	176.23	2.58	.009	.051
Pretest interest (covariate)	78.27	1	78.27	1.15	.285	.003
Instructional strategy	1,002.24	1	1,002.24	14.69	< .001	.037
Learning style	123.25	3	41.08	0.60	.614	.005
Strategy $\times$ learning style	301.44	3	100.48	1.47	.222	.011
Error	26,199.15	384	68.23			
Corrected total	27,608.97	392				

Note. Dependent variable: posttest interest score. $R^2 = .051$ (adjusted $R^2 = .031$). SS = Type III sum of squares; MS = mean square.

Table 3 shows a significant difference in the mean interest scores of students taught with the inquiry-based flipped classroom strategy and those taught with guided inquiry, $F(1, 384) = 14.69$, $p < .001$. The null hypothesis was therefore rejected. The partial η^2 of .037 indicates a small effect of instructional strategy on students' interest. The difference favoured students taught with the inquiry-based flipped classroom strategy.

H₀₂: There is no significant difference in the mean interest scores of students with different learning styles in Basic Science.

The Table 3 above shows no significant difference in the mean interest scores of students with different learning styles, $F(3, 384) = 0.60$, $p = .614$. The null hypothesis was therefore not rejected, and the partial η^2 of .005 indicates a negligible effect of learning style on students' interest.

H₀₃: There is no significant interaction effect of instructional strategy and learning style on students' interest in Basic Science.

Table 3 shows that the interaction between instructional strategy and learning style was not significant, $F(3, 384) = 1.47$, $p = .222$, with a partial η^2 of .011. The null hypothesis was therefore not rejected: the difference between the two strategies did not vary significantly across learning styles.

Discussion

Students taught Basic Science with the inquiry-based flipped classroom strategy had a significantly higher mean interest score than those taught with guided inquiry, although the effect was small. This advantage may be due to the video lessons and the variety of activities that the flipped classroom group received. Comparable studies have reported benefits of inquiry-based flipped instruction for learning outcomes and student engagement. Turan (2023) asserted that the

model involves students actively in the learning process and gives them more opportunities to understand concepts deeply, and George and Osuafor (2023) reported increased understanding and curiosity among students in inquiry-based flipped classes. Alqawasmi et al. (2023) and Zhen and Yahaya (2024) likewise concluded that flipped classroom instruction is effective in improving students' learning outcomes. The result of the study also revealed inquiry based flipped classroom instructional approach as a strategy that has the potential of exposing students to different types of scientific activities which are reflected in their development of interest in Basic Science. Justifying the above statement, Ndayebom and Aregbesola (2024) asserted that the way in which the Basic science teacher handles student in an instructional setting in a science class goes a long way in helping them to develop interest in Basic Science.

Aural and read/write learners had the highest mean gains, followed by kinaesthetic and visual learners, but learning style had no significant effect on interest, and it did not interact significantly with instructional strategy. This is consistent with the observation of Alqawasmi et al. (2023) that an inquiry-based flipped classroom lets the teacher use differentiated strategies that appeal to learners with diverse learning styles. A strategy that accommodates varied learners in this way would be expected to produce similar interest gains across learning styles. The finding differs from those Krishan and Al-rsa'i (2023), who reported significant effects of learning styles on academic achievement and on motivation to learn science, respectively.

Limitations

The findings should be interpreted with caution. Intact classes from only two schools were used, so school effects cannot be separated from strategy effects, and the design had no control group. The treatment lasted three weeks. Students were taught in classes but analysed as independent observations, which may overstate significance. The pretest covariate was not significant ($p = .285$), and the homogeneity of regression slopes was not reported.

Conclusion

Students taught Basic Science with the inquiry-based flipped classroom strategy had significantly higher interest scores than those taught with guided inquiry, although the effect was small. Learning style did not significantly influence interest, and the difference between the strategies did not vary significantly across learning styles. Based on the findings in this study, it was concluded that inquiry-based flipped classroom instructional approach is more effective in promoting students' interest than guided inquiry instructional approach in Basic Science irrespective of their learning style preferences.

Recommendations

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

1. Basic Science teachers should adopt the inquiry-based flipped classroom strategy for all learners, since the difference between strategies did not vary significantly across learning styles.
2. School administrators at all levels of education should provide adequate multimedia resources to teachers and train them to use these resources.
3. Teachers should as much as possible recognize the diverse learning styles of their students and employ comprehensive instructional strategies which will help them take care of these observed variations that impact significantly on learning outcomes.
4. Government, schools and professional bodies such as the Science Teachers Association of Nigeria (STAN) should organise regular in-service workshops and seminars for Basic Science teachers on the use of the inquiry-based flipped classroom strategy.

References

- Abidoeye, F., & Abidoeye, A. O. (2023). Hypotheses testing of variables of basic science teachers on performance of students in upper basic schools in Kwara State, Nigeria. *International Journal of Educational Research Review*, 8(2), 368–372.
- Adebola, F.F., & Adeleke, F.F. (2023). Literacy Curriculum Development for Basic Science and Management Science in Secondary Schools in Nigeria. *European Journal of Education and Pedagogy*, 4 (1), 15-20.
- Aliyu, J., Osman, S., Kumar, J. A., & Jamil, M. R. M. (2023). The design and development of a learning strategy to enhance students' engagement in simultaneous equations: An evaluation viewpoint. *Journal of Technology and Science Education*, 13(1), 36–52.
- Alqawasmi, A., Alsalthi, N., Shater, A., Aleassa, M., Almahdawi, A. A., & Alghazo, E. (2023). The impact of the flipped classroom model (FCM) on the academic intrinsic motivation (AIM) and lesson planning for science teacher-students in the postgraduate professional teaching diploma (PPTD) program at Al Ain University: A case study. *Eurasian Journal of Educational Research*, 103(103), 78–92.
- Assem, H. D., Owusu, M., Issah, S., & Issah, B. (2024). Identifying and dispelling students' misconceptions about electricity and magnetism using inquiry-based learning in selected junior high schools. *ASEAN Journal for Science Education*, 3(1), 13–32
- Bhakti, Y.B, Sumarni, R.A, Mayanty, S & Astuti, I.A. D. (2023). Developing Virtual Physics Practicum Module of Optic based on Guided Inquiry to improve students' science process skills. *Journal of Science & Science Education*, 4 (1), 39-49.
- Cam, A., Arslan, H. O., & Cigdemoglu, C. (2022). Flipped Learning Model-Learning Style Instruction: Supporting Pre-service Teachers on Science Teaching Methods and Personal Epistemologies. *International Journal of Science Education*, 33 (3), 323-334.
- George, P.C. & Osuafor, A.M. (2023). Effect of Flipped Classroom Instruction via Google Classroom on Secondary School Students Academic Attitude towards Chemistry in Onitsha Education Zone of Anambra State of Nigeria. *International Journal of Research and Innovation in Social Science*, 7 (6), 45-59.S
- Krishan, I. Q., & Al-rsa'i, M. S. (2023). The effect of technology-oriented differentiated instruction on motivation to learn science. *International Journal of Instruction*, 16(1), 15–19.
- Ndayebom, A.J. & Aregbesola, B.G. (2024). Problems facing Research Programme in Nigerian Tertiary Institutions. *European Journal of Higher Education and Academic Advancement*, 1 (2), 290-299.
- Nwoke, B.I, Mang, O. O, & Onuoha, E. (2023). Flipped Classroom and Development of Cognitive Skills in Mathematics among Secondary School Students. *South Eastern Journal of Research and Sustainable Development (SEJRSD)*, 13 (2), 93-113.
- Nworgu, B. G. (2015). *Educational research: Basic issues and methodology* (3rd ed.). University Trust Publishers.
- Nwuba, I., Awosika, O. F., & Osuafor, A. M. (2023). Fostering secondary school students' interest in biology using numbered heads together cooperative instructional strategy. *The University Academic Research Journal*, 5(2), 48–56.
- Ogunjimi, M. O., & Gbadeyanka, T. A. (2023). Effect of guided inquiry and explicit-instructional strategies on lower basic students' academic performance in mathematics. *Indonesian Journal of Teaching in Science*, 3(1), 23–32.

- Olamoyegun, S. O. (2023). Teaching and learning of basic science in Nigerian basic education schools. *Journal of Science, Research and Teaching*, 2(3), 49–56.
- Olaoye, T. V, & Awogbeja, M.D. (2023). Parent related Factors on Lower Primary Performance in Basic Science of Pupils in Ibadan North Local Government Area, Oyo State, Nigeria. *Journal of Educational Research in Developing Areas*, 4 (1), 100-112.
- Smida, D, Cipkova, E. & Fuchs, M. (2024). Developing the Test of Inquiry Skills: Measuring the Level of Inquiry Skills among Pupils in Slovakia. *International Journal of Science Education*, 46 (1), 73-108.
- Turan, Z. (2023). Evaluating whether flipped classrooms improve student learning in science education: A systematic review and meta-analysis. *Scandinavian Journal of Educational Research*, 67(1), 1–19.
- Uzoma-Nwogu, A.& Nwogu,U. I. (2023). Comparative Effectiveness of Flipped Classroom and e-learning Strategies on Digitalization of Tertiary in River State. *Journal of Education in Developing Areas*, 31 (3), 48-60.
- Zhen, H., & Yahaya, W. A. J. W. (2024). Use of generative AI tools to facilitate personalized learning in a flipped classroom. In *Transforming education with generative AI: Prompt engineering and synthetic content creation* (pp. 327–349). IGI Global.