

EXPLORING THE EFFECTS OF GROUP INVESTIGATION AND INDIVIDUALIZED LEARNING STRATEGIES ON STUDENTS' SCIENCE PROCESS SKILLS IN TRANSPORT SYSTEM**Ayodeji Temitope Ojo¹**

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* at.ojo@ui.edu.ng**ABSTRACT**

Biology is taught to equip students with the necessary science skills and the ability to transfer gained biological principles to their day-to-day activities. Despite this importance, evidence has shown that students struggle with manipulating these skills in biology. This has been attributed to the teacher-centred strategies adopted by biology teachers. Previous studies focus more on interventions to improve students' comprehension in biology, with a dearth of efforts on the acquisition of science process skills. This study was designed to determine the effect of group investigation (GILS) and individualized (ILS) learning strategies on students' science process skills (SPS) in the transport system in biology, Oyo State, Nigeria. The constructivist and Vygotsky's social constructivist theories provided the framework, while the pretest-posttest control group quasi-experimental design was adopted. The participants comprised 220 senior secondary school students divided into experimental groups and a control group. Six instruments were used to collect data. Data collected were analysed using analysis of covariance at $p < 0.05$. The results revealed that treatment had a significant main effect on students' acquisition of SPS in the transport system ($F_{(2,207)} = 104.16$, $p < 0.05$, Partial $\eta^2 = 0.50$). The participants in GILS ($\bar{x} = 21.35$) performed better than those in ILS ($\bar{x} = 18.62$) and CS ($\bar{x} = 13.38$). Attitude had no significant main effect on students' acquisition of SPS. The interaction effect of treatment and attitude was not significant on students' acquisition of SPS. Group investigation and individualized learning strategies enhanced students' acquisition of science process skills in the transport system. Biology teachers should adopt these strategies in the teaching and learning of transport systems.

Keywords: *Group investigation, individualized learning, attitude to biology, science process skills in biology.*

INTRODUCTION

The transport system is a fundamental concept in biology. All living organisms require mechanisms for the intake of oxygen, water, and nutrients, as well as for the elimination of waste products. Oxygen from the air is required by every cell in the human body. Likewise, water and minerals absorbed by plant roots from the soil must be transported to the leaves for photosynthesis. This underscores the necessity of efficient transport mechanisms within both plant and animal systems. Consequently, a sound understanding of the transport system is essential for appreciating biological processes that support growth, survival, and overall health.

Despite its importance, students' performance in this aspect of biology has consistently been low. Reports from the West African Examinations Council (WAEC) Chief Examiner on Biology indicated that candidates demonstrate poor comprehension of transport system concepts. For example, the West African Senior School Certificate Examination (WASSCE) Chief Examiner's Report (West African Examinations Council [WAEC], 2018) noted that many candidates were unable to explain how blood

loss in a car accident victim could be restored. The examiner attributed this poor performance to shallow knowledge of key concepts and inadequate competence in conducting experiments, taking readings, making observations, and drawing conclusions from experimental data. Similarly, in the 2022 examination, candidates were required to name a human blood cell that lacks a nucleus and state its biological implication. Many candidates failed to identify the correct cell and cannot explain its implications due to poor comprehension and inadequate conceptual understanding (WAEC, 2022).

Previous studies have attributed such poor performance to weak manipulation of science process skills. Jack (2013) observed that the abstract teaching of biology concepts without adequate practical experiences, coupled with poorly equipped laboratories, contributes significantly to students' low acquisition of science process skills. This deficiency is reflected in poor performance in public examinations. It is therefore imperative to actively involve students in the process of doing science. Ismail and Matore (2024) noted that students' scientific literacy can be effectively assessed through their science process skills.

Science process skills are essential competencies that facilitate the learning of science. They promote active participation, enhance students' sense of responsibility for their learning, and improve retention (Mirana, 2019). These skills include identifying problems, formulating hypotheses, designing investigations, collecting and analyzing data, interpreting evidence, drawing conclusions, and communicating findings. Scientists employ these skills in conducting investigations and solving problems (Darmaji et al., 2022); hence, they are fundamental to the effective application of the scientific method. Without these skills, students are unlikely to experience meaningful learning, which may contribute to declining interest and negative attitudes toward science (Mirana, 2019).

Recognizing the importance of skill acquisition in education, the Federal Republic of Nigeria (FRN, 2014) emphasized in the National Policy on Education that education should equip learners with appropriate skills, abilities, and competencies, both mental and physical, to enable them to contribute meaningfully to societal development. Practical application of science has been identified as an effective means of developing science process skills. Shana and Abulibdeh (2020) argued that practical activities significantly enhance skill acquisition, foster positive attitudes toward science, and promote deeper understanding in line with science education objectives. Similarly, Ahuja (2016) reported that science process skills make students active learners, increase retention, and facilitate inquiry-based knowledge construction. Such engagement enhances content understanding and academic achievement (Suman, 2020).

However, despite their importance, WAEC Chief Examiner's Reports (WAEC, 2018, 2022) continue to highlight students' poor manipulation of science process skills in biology. Empirical studies corroborate this trend. Mirana (2019) found that students' science process skills were inadequately developed. Bete (2020) reported poor process skills among Grade 8 chemistry students. Ugwuanyi and Nwafor (2021) observed low levels of competence in controlling variables, recording, communication, and inference in chemistry. Sholihah et al. (2020) reported that science process skill utilization among senior secondary physics students was low (47%). In biology, Roviati and Yuliani (2016) found low levels of skill acquisition in planning experiments, observation, prediction, and conclusion. Similarly, Pujiningrum and Admoko (2017) reported a generally low level of science process skills in biology.

Several factors have been identified as contributing to this low level of skill acquisition. Gunarhadi and Muzzazinah (2020) attributed it to the limited adoption of innovative instructional approaches. Rini (2017) identified infrequent experimental activities, inadequate use of innovative learning models, and poor utilization of instructional media as major factors. Haleem et al. (2022) highlighted inadequate facilities, ineffective teaching methods, limited teacher creativity, students' prior knowledge, and low motivation as contributing factors. Wola et al. (2023) further identified poor laboratory infrastructure and insufficient skill-oriented learning activities as additional constraints.

To address these challenges, Ndruru (2020) suggested adopting instructional strategies that directly engage students in acquiring and applying scientific skills. Various strategies have been explored,

including guided discovery (Namani & Yusuf, 2025), ethnoscience and traditional laboratory practical strategies (Ebere & Appolonia, 2022), and the Practical-Based Jigsaw Strategy (Nau & Djalo, 2019). Nevertheless, low levels of science process skills persist. This may be attributed to the limited integration of collaborative learning, reflective practice, self-paced learning, and opportunities for practical application within many of these strategies.

Group investigation and individualized learning strategies appear to address these gaps. Both are grounded in constructivist principles, which view knowledge as a product of social interaction and individual cognitive engagement (Curriculum Development Centre, 2016). However, research examining their implementation in secondary school biology, particularly in relation to science process skills, remains limited.

The group investigation strategy, developed as a framework for organizing collaborative inquiry (Slavin, 2009), enables students to work in small groups to plan and conduct investigations, synthesize findings, and present results to the class (Isjoni, 2009). The teacher facilitates access to resources and guides the investigative process. Studies have consistently demonstrated its effectiveness in enhancing academic achievement, process skills, and problem-solving abilities (Astuti, 2018; Suryani et al., 2020).

Individualized learning strategy, in contrast, is an active learning approach rooted in constructivist theory, which posits that learners construct knowledge through interaction with their environment. This strategy allows students to learn at their own pace, often through structured instructional packages, with minimal teacher intervention. It provides opportunities for independent inquiry and skill application. Studies by Elkhidir (2020) and Dawal (2021) revealed that individualized instruction significantly improved academic performance compared to conventional lecture methods in chemistry and biology.

Despite the potential of these strategies, certain moderating variables may influence their effectiveness. Variables such as attitude, gender, learning styles, and self-efficacy have been identified in biology education research. Attitude, in particular, has been widely recognized as a determinant of students' academic performance in science (Darmawan, 2020). Garba Kolo et al. (2017) defined attitude toward science as a predisposition reflecting an individual's likes or dislikes toward the subject. Positive attitudes have been linked to improved learning outcomes (Kamba et al., 2018). Zeidan and Jayosi (2015) found a significant relationship between science process skills and attitudes toward science, while Manguil and De Leon (2025) reported that attitude influenced students' acquisition of science process skills. However, limited research has examined the moderating effect of attitude on the relationship between instructional strategies and science process skill acquisition in biology. In this study, attitude was categorized as either positive or negative.

Against this backdrop, the present study investigated the effects of group investigation and individualized learning strategies on students' acquisition of selected science process skills in the transport system, including observing, formulating hypotheses, controlling variables, identifying relationships, defining operationally, inferring, and designing experiments. The study also examined the main and interaction effects of students' attitudes toward biology on their acquisition of these science process skills.

Hypotheses

The following null hypotheses were tested in this study at a $p < .05$ level of significance:

Ho1: There is no significant main effect of treatment on students' acquisition of science process skills in the transport system.

Ho2: There is no significant main effect of students' attitude to biology on students' acquisition of science process skills in the transport system.

Ho3: There is no significant main effect of treatment and students' attitude to biology on students' acquisition of science process skills in the transport system.

METHODOLOGY

Research Design

This study adopted the pretest–posttest control group quasi-experimental design to determine the efficacy of the intervention and to examine the moderating effect of attitude on the relationship between the instructional strategies and the dependent variable (posttest scores). The quasi-experimental design was considered appropriate because it allows the researcher to assign intact groups to treatment and control conditions without random assignment of individual participants (Capili & Anastasi, 2024). In this design, all groups were administered a pretest before the intervention. The treatment groups were then exposed to their respective instructional strategies, while the control group received the conventional method of instruction. Following the intervention, all groups completed a posttest to determine the effect of the treatment.

Selection of Participants

The participants comprised Senior Secondary School II (SS II) students offering biology in Oyo State, Nigeria. Oyo South Senatorial District was randomly selected from the three existing senatorial districts in the state (Oyo Central, Oyo North, and Oyo South) using the fishbowl technique without replacement. This sampling technique was adopted to ensure that each district had an equal probability of selection (Noor et al., 2022). From the nine local government areas within the Oyo South Senatorial District, two local government areas were randomly selected. Subsequently, three public secondary schools were purposively selected from each of the two selected local government areas, resulting in a total of six schools. The purposive selection was based on criteria such as the availability of biology teachers and functional laboratory facilities.

Within each local government area, one school was randomly assigned to each of the two treatment groups and the control group. An intact SS II science class was selected from each participating school to avoid disruption of existing class structures. Thus, the study involved six intact classes. A total of 220 students participated in the study, comprising 95 males and 125 females. The regular biology teachers in the participating schools served as research assistants throughout the study.

Six instruments were used in this study, and they are;

1. Student's Science Process Skills Worksheets in Biology (SSPSWB)
2. Biology Student Science Process Skills Rating Scale (BSSPSRS)
3. Students' Attitude to Biology Questionnaire (SABQ)
4. Teachers' Instructional Guide on Group Investigation Learning Strategy (TIGGILS)
5. Teachers' Instructional Guide on Individualized Learning Strategy (TIGILS)
6. Teachers' Instructional Guide on Conventional Lecture Method (TIGCLM)

Students' Science Process Skills Worksheets in Biology (SSPSWB). The Science Process Skills Practical Worksheet (SSPWB) was developed by the researcher to guide students in demonstrating the science process skills under investigation. The SSPWB consisted of two practical activities, each containing seven items designed to elicit students' application of specific science process skills. The individualized learning strategy and the conventional lecture method utilized the same version of the worksheet. However, a modified version was developed for the group investigation strategy to reflect the collaborative and inquiry-based nature of the approach. This version was structured to align with the stages of group-based investigative processes.

The SSPWB included items designed to assess students' abilities to observe, formulate hypotheses, identify and control variables, state relationships, define terms operationally, make inferences, and design experiments. To ensure validity, the instrument was subjected to face and content validation. Copies were given to experts in biology education and the research supervisor for critical review. The validators examined the instrument for clarity of language, relevance of items to the targeted science process skills, and appropriateness for the SS II student population. Their corrections, comments, and suggestions were incorporated into the final version of the instrument.

Biology Student Science Process Skills Rating Scale (BSSPSRS). The researcher developed the Biology Students' Science Process Skills Rating Scale (BSSPSRS) to assess students' acquisition of science process skills as demonstrated through the practical activities contained in the worksheets. The instrument was used to rate students' performance in observation, controlling variables, inferring, identifying relationships, formulating hypotheses, defining operationally, and experimentation during practical sessions. The BSSPSRS comprised performance descriptors for each skill, rated on a five-point continuum ranging from 0 (very low ability to demonstrate the skill) to 5 (very high ability or full demonstration of the skill). The scale provided a structured framework for evaluating the extent to which students exhibited each targeted science process skill during the intervention.

To establish reliability, the instrument was pilot-tested on 27 SS II science students from a school that was not included in the main study. Two independent raters used the instrument to assess the students' performance. Inter-rater reliability was estimated using Scott's κ coefficient. The reliability indices obtained for each skill were as follows: observation ($\kappa = .78$), formulating hypotheses ($\kappa = .76$), controlling variables ($\kappa = .76$), defining operationally ($\kappa = .75$), identifying relationships ($\kappa = .75$), inferring ($\kappa = .78$), and experimentation ($\kappa = .77$). These coefficients indicate acceptable levels of inter-rater agreement for research purposes.

Students' Attitude to Biology Questionnaire (SABQ). The researcher developed the Students' Attitude toward Biology Questionnaire (SABQ) to measure students' attitudes toward biology. The final version of the instrument consisted of 15 items structured on a four-point Likert-type scale with response options of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). For positively worded items, responses were scored as follows: SA = 4, A = 3, D = 2, and SD = 1. For negatively worded items, the scoring was reversed: SA = 1, A = 2, D = 3, and SD = 4. This scoring procedure ensured that higher total scores reflected more positive attitudes toward biology.

To establish face and content validity, the initial pool of 35 items was submitted to three science education experts for evaluation. The experts assessed the items for clarity of expression, appropriateness of language, suitability for the target class level, content coverage, relevance to the construct being measured, and alignment with the study objectives. Based on their recommendations, 20 items were retained, and the response format was standardized to a four-point Likert-type scale. The revised 20-item instrument was pilot-tested on 27 SS II science students from a school not included in the main study. The data collected were analyzed using Cronbach's alpha to determine internal consistency reliability. To improve the reliability index, five items with low item-total correlations were removed. The final 15-item instrument yielded a Cronbach's alpha coefficient of .79, indicating acceptable internal consistency for research purposes.

Application of the Intervention

Experimental Group 1. Treatment in this group involved a group investigation learning strategy in the following steps, as adapted from Slavin (2009):

Step 1: Identification of topics and organization of students into research groups

- i. The teacher identifies the general topic and guides students, through discussion, to determine relevant subtopics.
- ii. The teacher forms heterogeneous groups of 4–6 members based on students' attitudes toward biology (positive or negative). The class size determines the number of groups formed.
- iii. Each group chooses a subtopic of interest and develops questions for investigation.

Step 2: Planning of the groups' investigations

- i. Students collaborate to plan how they will conduct their investigation and develop research questions related to their chosen subtopics. They assign responsibilities to individual members or pairs and decide on appropriate procedures.

- ii. The groups identify the resources they will need and determine how to obtain relevant materials and information.

Step 3: Execution of group investigations

- i. Each student or pair carries out the assigned aspect of the investigation. They apply skills such as application, analysis, synthesis, and evaluation in processing the collected information. Although responsibilities are divided, members work collaboratively and support one another throughout the process.
- ii. Upon completion of their tasks, each member writes a summary of their findings, which contributes to the overall group report.

Step 4: Planning of group presentations

- i. The teacher forms a steering committee comprising one representative from each group to coordinate presentations and the use of instructional materials.
- ii. Each group plans how to present its findings to the entire class.

Step 5: Group presentations of their new experiences

- i. Each group presents a summary of the results of its investigation to ensure that all students gain a comprehensive understanding of the general topic.

Step 6: The teacher and students evaluate their work

The performance of both individual students and groups is assessed.

- ii. The teacher assesses each group as a whole. Groups respond to questions from the class, except those submitted by their own group.
- iii. The teacher also assesses individual students by observing their participation during the project and evaluating their individual contributions and the final group report.

Experimental Group 2. Treatment in this group involved an individualized learning strategy in the following steps:

Step 1: Objective statement

- i. The teacher states the behavioral objectives to be achieved at the end of the lesson.

Step 2: Diagnosis

- i. The teacher assesses students' prior knowledge and abilities in relation to the stated lesson objectives through questioning and brief diagnostic activities.

Step 3: Review and distribution of materials

- i. The teacher reviews and selects appropriate instructional resources (materials, activities, and equipment) to facilitate the achievement of the stated objectives.
- ii. The teacher distributes the developed biology instructional materials to each student.

Step 4: Implementation

- i. Each student begins independent study using the developed materials and provided resources.
- ii. The teacher acts as a facilitator, providing guidance through one-on-one mini-lessons where necessary.

Step 5: Ongoing evaluation

- i. Students work through the instructional materials and monitor their progress by completing embedded questions and activities.
- ii. The teacher continuously assesses each student's progress through observation and feedback.

Step 6: Mastery testing

- i. The teacher evaluates students’ achievement to determine their level of content mastery, using tests or structured questions.
- ii. Students who demonstrate mastery proceed to new objectives, while those who do not receive review and remediation before reassessment.

Methods of Data Analysis

The data obtained from the pretest and posttest were analyzed using Analysis of Covariance (ANCOVA). The posttest scores served as the dependent variable, while the pretest scores were treated as covariates to control for initial group differences. This approach helped to adjust the post-intervention means and provide a more accurate estimate of the treatment effects. Estimated marginal means were computed to compare the adjusted mean scores of the different groups and to determine the magnitude of differences among them. Where significant main effects were observed, pairwise comparisons were conducted using the Bonferroni post hoc test to identify the specific group differences.

FINDINGS

Ho1: There is no significant main effect of treatment on students’ acquisition of science process skills in biology

To do this, pretest and post-test data gathered from students on the biology student science process skills rating scale were subjected to ANCOVA, and the result is presented in Table 1.

Table 1. Summary Of Analysis Of Covariance Of Acquisition Of Science Process Skills

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta ²
Corrected Model	5624.969	12	468.747	51.453	0.000	0.749
Pre-process skill	1089.402	1	1089.402	119.581	0.000	0.366
Treatment	1897.797		948.899	104.158	0.000*	0.502
Attitude	21.525	2	21.525	2.363	0.126	0.011
Treatment x Attitude	3.168	1	1.584	0.174	0.841	0.002
Error	1885.809	2	9.110			
Total	7510.777	207				
Corrected total		219				

*Significant at $p < .05$

Table 1 shows that there was a statistically significant main effect of treatment on students’ posttest acquisition of science process skills in the transport system ($F_{(2, 207)} = 104.16, p < 0.05, \text{partial } \eta^2 = 0.50$). The effect size (partial $\eta^2 = 0.50$) indicates that 50% of the variance in students’ posttest science process skills scores was attributable to the treatment conditions after controlling for pretest scores. This represents a large effect size. Based on this result, Hypothesis 1 was rejected. This finding implies that there were significant differences in the science process skills acquisition scores of students exposed to the different instructional strategies. To determine the magnitude and direction of the adjusted mean differences among the groups, estimated marginal means (EMMs) were computed. The results are presented in Table 2.

Table 2. Estimated Marginal Means of Posttest Acquisition of Science Process Skills

Treatment group	Mean	Std. Error
Group Investigation Learning Strategy (GILS)	21.35	0.60
Individualized Learning Strategy (ILS)	18.62	0.35

Conventional Strategy (CS)	13.38	0.42
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Table 2 shows that students in the Group Investigation Learning Strategy (GILS) experimental group had the highest mean score in the acquisition of science process skills in the transport system (21.35), followed by the Individualized Learning Strategy (ILS) group (18.62), and finally the Conventional Strategy (CS) group (13.38). This pattern of performance can be represented as GILS > ILS > CS. To identify which specific groups differed significantly from each other, a Bonferroni post hoc test was conducted. The results of this analysis are presented in Table 3.

Table 3. *Bonferroni Post-hoc Tests Analysis of post-Acquisition of Science Process Skills*

Treatment	N	Mean	GILS	ILS	CS
GILS	111	21.35		*	*
ILS	38	18.62	*		*
CS	71	13.38	*	*	

*Significant at $p < 0.05$

The results of the Bonferroni post hoc test presented in Table 3 indicate that the Group Investigation Learning Strategy (GILS) group performed significantly better than both the Individualized Learning Strategy (ILS) and Conventional Strategy (CS) groups on the posttest of science process skills. Additionally, there was a significant difference between the ILS and CS groups, with students exposed to ILS achieving higher mean scores than those in the CS group. These findings indicate a clear pattern in the effectiveness of the instructional strategies: CS < ILS < GILS. In other words, the conventional strategy was less effective than the individualized learning strategy, and the individualized learning strategy, in turn, was less effective than the group investigation learning strategy in promoting students' acquisition of science process skills in biology.

Ho2: There is no significant main effect of attitude to biology on students' acquisition of science process skills in biology

To test Hypotheses 2 and 3, data obtained from students' pretest and posttest scores on the Science Process Skills Rating Scale (BSSPSRS) and the Students' Attitude toward Biology Questionnaire (SABQ) were subjected to Analysis of Covariance (ANCOVA). The results are presented in Table 1.

The ANCOVA results indicated that there was no significant main effect of students' attitude toward biology on their acquisition of science process skills ($F_{(1, 207)} = 2.36, p > 0.05$). Consequently, Hypothesis 2 was not rejected. This finding suggests that students' attitudes toward biology did not have a statistically significant impact on their posttest scores in science process skills.

Ho3: There was no significant main effect of treatment and students' attitude to biology on students' acquisition of science process skills in biology

The ANCOVA results presented in Table 1 indicated that the two-way interaction effect of treatment and students' attitude toward biology on the acquisition of science process skills was not statistically significant ($F_{(2, 207)} = 0.17, p > 0.05$). Consequently, the null Hypothesis 3 was not rejected. This finding suggests that students' attitudes toward biology did not significantly interact with the effect of the instructional strategies on their posttest science process skills scores. In other words, the impact of the different learning strategies on students' acquisition of science process skills was not influenced by whether students held positive or negative attitudes toward biology.

DISCUSSION

The results of this study indicated that the instructional treatment had a significant main effect on students' acquisition of science process skills in biology. Specifically, the Group Investigation Learning Strategy (GILS) was the most effective, followed by the Individualized Learning Strategy (ILS), while the Conventional Strategy (CS) was the least effective.

The superior efficacy of the GILS may be attributed to the collaborative and interactive nature of the strategy. By working in groups, students engaged in dialogues and activities that involved planning, investigating, analyzing, drawing inferences, formulating conclusions, and evaluating the information they obtained. This interactive process facilitated the development of critical skills and promoted knowledge construction. Additionally, students were able to transfer what they could do independently to tasks completed with instructional support. These findings imply that group-based learning, which emphasizes sharing, analyzing, evaluating ideas, and collaboratively developing solutions, can enhance students' acquisition of science process skills.

This finding aligns with Vygotsky's social constructivist theory (Vygotsky, 1978), which posits that a child's development depends on interactions with peers and the availability of necessary resources. The present results are also consistent with previous studies by Astiti (2018) and Suryani et al. (2020), who reported that students in group investigation settings outperformed those taught via whole-class instruction in physics learning outcomes and problem-solving skills in mathematics, respectively. Similarly, Tifi et al. (2006) observed that group-based investigations enable learners to reach their own conclusions while simultaneously developing social skills such as collaboration, sharing, debating, and extending ideas.

The ILS was also found to be more effective than the conventional strategy. This outcome may be because ILS allows students to learn individually at their own pace and in their preferred manner, constructing knowledge and skills in relation to their environment in accordance with constructivist principles. Teachers provided guidance and support throughout the learning process, which facilitated deeper understanding. This finding is consistent with Dawal (2021), who reported that individualized learning strategies outperform conventional methods in promoting achievement in Basic Science, Technology, and Chemistry. Likewise, Elkhidir (2020) found that individualized learning is an effective approach for teaching biology at the secondary school level.

Regarding students' attitudes toward biology, the study found no significant effect on the acquisition of science process skills. This result aligns with prior research conducted by Ahmad and Asghar (2011) in biology and by Ali and Awan (2013) in physics, chemistry, biology, and mathematics, which also reported that students' attitudes do not necessarily predict their acquisition of scientific skills.

Finally, the study revealed no significant interaction effect between treatment and students' attitude toward biology on the acquisition of science process skills. This suggests that the combined influence of instructional strategy and individual attitude does not exert a statistically significant effect on students' learning outcomes. Although students with positive attitudes contributed slightly more to the overall variance and those with negative attitudes contributed the least, the differences in their respective means were not statistically significant.

CONCLUSION

It can be concluded that both the Group Investigation Learning Strategy (GILS) and the Individualized Learning Strategy (ILS) significantly enhanced secondary school students' acquisition of science process skills in biology. In contrast, students' attitudes toward biology did not significantly influence their acquisition of these skills. The significance of this research lies in demonstrating the effectiveness of implementing group-based and individualized learning strategies in biology classrooms. The findings highlight that group learning is not solely a cognitive development strategy but also serves as a catalyst for the acquisition of a broad range of skills, particularly in practical and inquiry-based science activities.

Future studies could explore the long-term effects of GILS and ILS on students' cognitive, affective, and psychomotor domains, providing deeper insights into the sustainability and generalizability of these strategies. Additionally, comparative research across different educational levels could further enhance understanding of the applicability of these strategies. Factors such as students' prior experiences, abilities, and learning styles may also be considered as potential moderator variables in future investigations to refine instructional approaches and optimize learning outcomes.

Based on the findings of the study, the following recommendations were made:

1. Biology teachers at the secondary school level should adopt Group Investigation and Individualized Learning Strategies in the teaching and learning of biology to enhance students' acquisition of science process skills.
2. The government, through the Ministry of Education and relevant agencies or professional associations, should organize seminars, workshops, and training programs to support teachers in the effective implementation of these strategies in biology classrooms.

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