



Effects of Individualised and Cooperative Reflective Journal Writing Strategies on Secondary School Students' Achievement in Biology in Kwara State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author ATI designed the study, wrote the protocol and supervised the work. Authors ATI and EKA carried out all the fieldwork and performed the statistical analysis. Author ATI wrote the first draft of the manuscript. Author ATI managed the literature searches and edited the manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJESBS/2016/24699

Editor(s):

(1) Shao-I Chiu, Taipei College of Maritime Technology of Center for General Education, Taiwan.

Reviewers:

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Complete Peer review History: <http://sciencedomain.org/review-history/14280>

Original Research Article

Received 29th January 2016

Accepted 13th April 2016

Published 21st April 2016

ABSTRACT

The study investigated the effects of individualised and cooperative reflective journal writing strategies on secondary school students' achievement in Biology. The study adopted a pretest-posttest, control group, quasi-experimental design of a 3x3x2 factorial matrix. The participants consisted of 208 senior secondary school II students from two Local Government Areas in Kwara State. The two instruments for data collection were: Students' Achievement Test in biology and Verbal Ability Test. Three hypotheses were tested at 0.05 level of significance. Data were analysed using Analysis of Covariance and Sheffe post-hoc test. The result revealed that individualised and cooperative reflective journal writing strategies improved the achievement of students in Biology

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($F_{(2,189)} = 111.560, P < .05, \eta^2 = .541$). It was also found that students exposed to cooperative reflective journal writing strategy had higher achievement mean score of ($\bar{x} = 19.13$) than those exposed to individualised reflective journal writing strategy ($\bar{x} = 18.72$). The mean score ($\bar{x} = 10.67$) of those exposed to conventional method was the least. It was recommended that teachers should adopt individualized reflective journal writing and cooperative reflective journal writing strategies to improve the achievement of students in senior secondary school in Biology.

Keywords: Cooperative reflective journal writing; individualised reflective journal writing; achievement; verbal ability; gender.

1. BACKGROUND TO THE STUDY

The major aims and expectations of teaching and learning programmes are productivity and positive-evaluated end-product (achievement). In recent times however, observations on students' academic performance in science generally and Biology in particular over the years in the results of Senior Secondary Certificate Examination (SSCE) conducted by the West African Examination council (WAEC) and National Examination Council (NECO) revealed that students performance has been poor.

Poor academic achievement in science has been reported in literature [1]. [1] pointed out the following as the main variables causing poor performance in science (i) Over crowded laboratory (ii) Lack of adequate textbooks (iii) the pressure of external certificate examination and (v) the use of archaic teaching methods. Literature has repeatedly drawn attention to the fact that teaching in secondary school science classes is very often highly teacher-centered and the use of instructional strategies which have not totally incorporated learners' previous knowledge and their reasoning patterns is common [2-5]. This is more so as instructional strategies adopted by teachers have not solved the problem probably because those strategies have not actually focused on learners as constructors of their own theories and knowledge. Learners need to be made to construct their own knowledge and ideas in learning because they are the architects of their own learning and constructors of their own ideas and knowledge [3]. Otherwise, continued use of teacher-centered or teacher-dominated strategies would yield nothing but learning by rote thereby making it difficult for students to recall pieces of information from memory. There have been concerted efforts at getting learners more actively involved in the learning process and solving the problem of large class size through the development of methods and approaches

that promote student-student interaction and enable students to monitor how they learn. Reflective journal writing is one such approach.

Reflective journal writing is one of the techniques that can improve students' achievement in biology at the secondary school level as it is a technique that combines metacognitive processing with learning. Reflective journal writing is an effective learning technique that enables students to learn while they are writing. Students can use journals for a number of purposes such as writing about interesting topics, expanding their imagination, and establishing connections between new information and the things they already know according to [6]. It may also facilitate a student's review and correction of his initial ideas and therefore lead to more acceptable work [7]. In promotion of attitude and meta-cognition, students who gradually understand their learning role during the course of reflection can have an insight into their thinking process and their characteristics, attitude, attention, dominance, persistence, and other fundamental responsibilities [8]. A number of studies suggested that reflective journal writing enhances reflection, integration of theory with practice, and promotes professional growth [9,10,11,12,6] and also improves student assessment performance [13].

During reflective journal writing students are provided with opportunities to: record events, reflect personally, raise questions about the environment and react to experiences [14]. Reflective journal writing is premised on the experiential learning theory propounded by [15]. According to this theory, knowledge is created through the transformation of experience. [15] stated that knowledge has to be discovered by the individual if it is to have any significant meaning to them; in addition this theory asserts that the person's commitment to learning is highest when they are free to set their own learning objectives and are able to actively

pursue them within a given framework. According to Kolb's experiential learning cycle there are four major stages of effective learning. These include concrete experience, reflective observation, abstract conceptualization, and active experimentation. The concrete experience involves doing something or a particular action to observe the effects of the action. The reflective observation stage involves the practitioner stepping back from the task involvement and reviewing what has been done and was experienced during task involvement. During the abstract conceptualization the learner interprets the events and the relationship among the events is established through critical thinking. Abstract conceptualization involves better comprehension and the ability to draw new ideas from the experience for future experience. At the active experimentation stage the abstract concepts are applied to new circumstances within the range of generalization. According to [16] the first stage of reflective journal writing is awareness which is usually done through the stimulation of students' thoughts about an event; this may be achieved through teaching that went well or that did not go well. This is similar to the concrete experience as stated in [15]. The second stage of reflection is the individual critical analysis of the event, exploring what happened and why. This stage is an integration of the observation and reflection and formation of abstract concepts stages. The final stage of reflective journal writing is in line with Kolb's final stage because after reflection new perspectives emerge about the events and the learner is able to communicate these through writing.

During the second stage of reflection, which entails critical analysis of the concrete experience or the event presented to explore what happened and why before new perspective emerges, there is a possibility for the learner to reflect alone or do it cooperatively with peers. The nature of the reflective journal writing instructional strategy allows the learner to create new thoughts and feelings that push the learning into long-term memory if carried out individually or as a group (cooperative learning).

Cooperative learning can be used to transform classroom instruction into a series of rich memorable experiences and thus reduce boredom and forgetfulness in students' learning of Biology. Cooperative learning is a successful strategy in which small teams, each with students of similar or different abilities, use a variety of learning activities to improve their

understanding of a subject [17]. When effectively implemented, cooperative learning improves information acquisition and retention of higher-level thinking skills, interpersonal and communication skills and self-confidence [18]. [19] described cooperative learning as small groups of students organized for study. Members of the group work cooperatively together to find solutions to hypothetical or real life problems. The strategy has been proven to be effective for all types of students, including the academically gifted, the average students and the slow learners, because it promotes learning and fosters respect and friendship among diverse groups of students [20]. A review of studies on the effects of cooperative learning on students' achievement indicated that cooperative learning gains are not limited to a particular ability level or sex but to all who engage in it [21]. A Study by [21] also reaffirmed the ability of cooperative learning when used as an instructional strategy to bring about significant improvement in students' achievement in school science subjects. Cooperative reflective journal writing involves students working cooperatively as they reflect on classroom tasks. Cooperative groups may be same or mixed gender groups.

Apart from the teaching strategy, students' gender is another factor that is of great importance in their learning. The issue of gender and academic achievement in science has received much attention yet results on this have been inconclusive. Yet it remains one of the issues in science and education because researchers have linked it to achievement and participation in certain professions [22]. [23] asserted that there have been conflicting findings on how gender influences students' achievement. Several research findings at different levels of education in Nigeria indicated that females are grossly underrepresented in terms of enrolment, participation and performance or achievement in science education [24,25]. Some researchers have reported a significant gender-group difference in favour of boys in performance of students in science and mathematics [26]. [27] supports the same opinion in her study of teaching strategies and determinants of achievement, finding that male achievement is consistently higher than that of females. According to her view, this might be because boys perceive science as a male domain and girls see themselves as cognitively inferior to boys. However, [28,23] in their separate studies reported that there is no significant difference between male and female

achievement in science. [29] reported that boys perform better than girls on physical science questions and high level questions (application, analysis and synthesis) whereas girls do better than boys in questions related to biological sciences and lower level questions (knowledge, recall and comprehension questions). The results of these studies revealed that biology is somewhat more attractive to females compared to males and vice versa.

In addition to gender, verbal ability is another factor that has great influence on students' learning. Given the nature of journal writing itself, students' verbal ability can greatly affect the achievement of students when exposed to both types of reflective journal writing. Verbal ability refers to an individual's intelligence or language development level and his/her ability to do abstract reasoning [30]. Verbal ability was defined as a student's ability to apply knowledge and to utilize cognitive strategies in analyzing information and drawing inferences, to deduce relationships and generalize verbal attributes, and to predict outcomes and evaluate the appropriateness of predictions and strategies [31]. Some studies have shown that there is a relationship between students' verbal ability and their academic achievement. [32-34,30] in their separate studies reported that high verbal ability students tend to achieve better than low verbal ability students. [35] on the other hand opined that there is no relationship between verbal ability and academic achievement. In view of differing statements on the importance of verbal ability on learners' achievement, this study will further investigate the variable with respect to individualised and cooperative reflective journal writing on students' achievement in and attitude toward Biology.

1.1 Statement of the Problem

The major aims and expectations of any teaching and learning programme are productivity and a positive-evaluated end-product (achievement). Science educators, parents and other stakeholders in science education have been concerned about the poor performance of students on the Senior Secondary Certificate Examination (SSCE) in biology. In spite of the important position of biology among other science subjects and related disciplines, literature has revealed that students' performance in biology on the Senior Secondary School Certificate Examination (SSSCE) has been consistently poor. To achieve mastery of

biological concepts, several instructional strategies have been used over the years. Traditionally educators have been using the lecture method of teaching to teach biological concepts with little or no activities. This makes the concept difficult for students to grasp, which may later lead to the poor performance of students in Biology. Research has shown that instructional strategies that are learner centered and encourage students to actively monitor their learning tend to yield better achievement for students. Therefore, this study examined the effect of two modes of reflective journal writing (cooperative and individualized) strategies along with the moderating effects of gender and verbal ability on students' achievement in Biology.

1.2 Hypotheses

The following three null hypotheses will be tested:

H₀₁: There is no significant main effect of treatment on students' achievement in biology

H₀₂: There is no significant main effect of students' verbal ability on students' achievement in biology

H₀₃: There is no significant main effect of gender on students' achievement in biology

1.3 Scope of the Study

This study covered two hundred and eight Senior Secondary School two biology students. The topic covered in this study was transport system in plants and the circulatory system in animals. The study also examined the effects of individualized and cooperative reflective journal strategies in biology on students' achievement in biology for eight weeks before and after which their achievement was measured. The schools were assigned to each treatment and control group to make three schools in each of the local government.

1.4 Area of the Study

The schools that participated in the study were from two Local government Areas of Kwara Central Senatorial district.

2. METHODOLOGY

This study adopted a pretest - posttest, control group quasi-experimental design involving a 3 X

3 X 2 factorial matrix. The treatment was the instructional strategy at three levels (individualized reflective journal writing, cooperative reflective journal writing and conventional method) Moderator variables included verbal ability at three levels (low, medium and high) and gender at two levels (male and female). Students' achievement in biology was the dependent variable.

2.1 Sampling and Sampling Technique

The study population was all the senior secondary school two students in Kwara central senatorial district. A multistage sampling technique was used to pick 208 students for the study. At the first stage of sampling two local governments were randomly selected out of the 5 local governments in the senatorial district. At the second stage, three coeducational schools were selected purposively in each of the local government areas to make a total of six schools in order to maximize gender as one of the moderating variables. In all the schools intact classes were used.

Schematic representation of the design

O ₁	X ₁	O ₂	(E ₁)
O ₃	X ₂	O ₄	(E ₂)
O ₅	X ₃	O ₆	(C)

Where O₁, O₃ and O₅ represent the pretest scores of individualized reflective journal writing strategy (E₁), cooperative reflective journal writing strategy (E₂) and conventional method (C) respectively. O₂ and O₄ are the posttest scores of the treatment groups and O₆ is the posttest of the control group.

X₁ represents treatment for experimental group one E₁ (Individualized reflective journal writing strategy) X₂ represents treatment for cooperative group two E₂ (cooperative reflective journal writing) X₃ represents treatment for control group C (conventional method)

2.2 Research Instruments

The following instruments were used to collect data for the study:

- I. Students' Achievement Test in biology (SATB).
- II. Students' Verbal Ability Test (SVAT).

- III. Teachers' instructional Guide on Individualized Reflective journal Writing Strategy (TIGIRJWS).
- IV. Teachers' Instructional Guide on Cooperative Reflective Journal Writing Strategy (TIGCRJWS).
- V. Teachers' instructional Guide on conventional method (TIGCM).
- VI. Teachers' Performance Evaluation Sheet (TPES).

Students' Achievement Test in biology (SATB) was developed by the researcher to measure the cognitive level of the students on the concept of transport systems (in plants and animals) in biology before and after the implementation of the intervention. The instrument consisted of twenty-five (25) multiple choice questions with options A – D. Each correct answer in SATB was rewarded one mark; to make a total of 25 marks. The face validity of the instrument was done by science education experts to determine its suitability and the reliability coefficient of 0.86 was obtained using Kuder-Richardson formula-20 (KR-20). The choice of KR-20 was premised on the inequality in the level of difficulty of the items in the Biology achievement test.

Student' Verbal Ability Test (SVAT) consisted of 36 multiple choice objective test items with options ranging from 1-6. SVAT was adopted from the Australian Council for Educational Research (ACER) that tests verbal ability. However, the researcher re-validated the test to ascertain its suitability for this study The 36 items were trial-tested on twenty (20) senior secondary school II students in a school that was not selected for the main study. The data collected were analysed using Kuder-Richardson formula 20 (Kr20) and a reliability of 0.77 was obtained. Kr20 was used because of the inequality of the difficulty level of the items in the SVAT.

Teachers' instructional Guide on Individualized Reflective journal Writing Strategy (TIGIRJWS), Teachers' Instructional Guide on Cooperative Reflective Journal Writing Strategy (TIGCRJWS) and Teachers' instructional Guide on conventional method (TIGCM) are the lesson notes, which were prepared on a weekly basis for the eight weeks of the treatment for the study. The duration for each lesson was 80 minutes (double periods). The essence of these instruments was to guide the research assistants (teachers) on the use of steps and procedure followed during the treatment.

2.3 Procedure for Study

In carrying out the treatment, the following procedure was adopted:

During the study the first week was used to train the research assistants and to conduct pre-tests. Treatment lasted for five weeks utilizing the two 80 minutes periods. Post- test were conducted for all groups in the last week.

X	Procedures
Individualized reflective journal writing strategy	<ol style="list-style-type: none"> 1 Teacher presents the topic 2 Teacher tells the students the task to be done 3 Teacher highlights the major ideas within the topic to be taught 4 Teacher gives students a few minutes to review the lesson 5 Teacher asks each student to write a journal based on the lesson using the following guidelines: <ol style="list-style-type: none"> a. What question do you have about this lesson? b. What have you learned in the lesson? c. What area did you find difficult? d. What area did you find interesting? e. How do you think this lesson will be useful for you to apply outside the classroom? 6 Teacher collects the journal for compilation of entries. 7 Raised questions were thrown to the class for answer in the next lesson. 8 Teacher evaluates learning of concepts based on individual reports.
Cooperative reflective journal writing	<ol style="list-style-type: none"> 1 Teacher presents the topic 2 Teacher tells the students the task to be done 3 Teacher highlights the major ideas within the topic to be taught. 4 Teacher groups students in five-member heterogeneous teams by gender only. Each group appoints a leader and clerk 6 Teacher gives groups a few minutes to review the lesson and share their views 7 The team writes a group journal based on the following guidelines: <ol style="list-style-type: none"> a. What question do you have about this lesson? b. What have you learned in the lesson? c. What areas did you find difficult? d. What areas did you find interesting? e. How do you think this lesson will be useful for you to apply outside the classroom? 8 Teacher collects the group journal for compilation of entries. 9 Raised group question was thrown to the groups for answer in the next lesson. 10 Students learning were evaluated based on group entries
Conventional Strategy	<p>Teacher presents the topic</p> <ol style="list-style-type: none"> 1. Teacher tells the students the task to be done 2. Teacher highlights the major ideas within the topic to be taught. 3. Teacher explains the content of the lesson step by step 4. Teacher solicits for students' questions and 5. Teacher asks question to evaluate students' learning of the concept. 6. Teacher gives the students assignment

3. RESULTS

3.1 Testing of Hypotheses

H01: There is no significant main effect of treatment on students' achievement in Biology.

Table 1 represents the summary of ANCOVA (using the pretest as the covariate) results on subjects' posttest achievement scores.

The result shows that there was a significant main effect of Treatment groups on the students' posttest Achievement scores ($F_{(2,189)} = 111.560$, $P < .05$, $\eta^2 = .541$). The effect size of 54.1% was moderate. Therefore the null hypothesis is rejected. This means that there was a significant difference in the mean achievement scores of students in each treatment. On the basis of this finding, hypothesis 1a was rejected. Mean scores are shown in Table 2.

From the Table 2, the Cooperative reflective journal writing strategy had the highest mean score of ($\bar{x} = 19.13$) followed by the Individualised

reflective journal writing strategy ($\bar{x} = 18.72$) and lastly followed by the Conventional Method ($\bar{x} = 10.67$). Further, the source of the significant difference obtained in Table 3 was traced using Scheffe post-hoc tests.

Post-hoc analysis revealed that the Cooperative reflective journal writing strategy (CRJWS) yielded significantly higher scores than Individualised reflective journal writing strategy (IRJWS) and conventional method (CM). The Individualised reflective journal writing strategy was significantly lower than cooperative reflective journal writing strategy and higher than the conventional method in achievement scores. The difference in the posttest mean scores of the CRJWS and IRJWS is just 0.952. However, the posttest mean scores of the CRJWS and the IRJWS exceed that of the CM by 8.46 and 7.50 respectively. The wide margin between the means of CRJWS and CM as well as IRJWS and CM is an indication that each of the two modes of reflective journal writing results in better achievement than the CM. In addition to this, the best level of achievement in biology was attained when the reflective journal writing was done cooperatively.

Table 1. 3 x 3 x 2 ANCOVA of post test achievement scores of students by treatment, verbal ability and gender in biology

Source	DF	F	Sig.	Eta ² / Effect size
Corrected model	18	21.481	.000	.672
Pre achievement	1	14.350	.000	.071
Main effect				
Treatment	2	111.560	.000*	.541
Verbal ability	2	7.538	.001*	0.74
Gender	1	.636	.426	.003
2-way interactions				
Treatment x Verbal ability	4	1.515	.199	.031
Treatment x Gender	2	.261	.771	.003
Verbal ability x Gender	2	1.914	.150	.020
3-way interactions				
Treatment x Verbal x Gender	4	.851	.494	.018
Error	189			
Total	207			

*denotes significant at $p < .05$

Table 2. Estimated marginal means of posttests achievement scores by treatment and control group

Treatment group	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
Individualised reflective journal writing strategy	18.72	.508	17.71	19.72
Cooperative reflective journal writing strategy	19.13	.481	18.18	20.08
Conventional method	10.67	.432	9.81	11.52

Ho2: There is no significant main effect of verbal ability on students' Achievement in biology

The results in Table 1 showed that there was a significant main effect of verbal ability on the posttest achievement results of students in biology ($F_{(2,189)} = 7.538, P < .05, \eta^2 = .074$). The effect size of 7.4% was fair. Therefore, hypothesis 2a was rejected. This implies that the verbal ability has a main significant effect on students' achievement in Biology regardless of their treatment status.

From Table 4, students with high Verbal Ability had the highest mean score of (17.50) followed by those with medium Verbal Ability (16.13) and lastly followed by low Verbal Ability (14.89). Table 6 shows the scheffe post-hoc analysis.

Table 5 indicates that High Verbal Ability Students (HVA) had a significantly higher post test mean score than those students with Medium Verbal Ability (MVA) and those with Low Verbal Ability (LVA). Similarly, students with MVA had a significantly higher mean score than those with low verbal ability. This implies that students with high verbal ability had better scores in the transport system than their counter parts with MVA and LVA.

Ho3: There is no significant main effect of gender on students' achievement in biology.

The results in Table 1 showed that there was no significant main effect of Gender on students' Achievement in biology $F_{(1, 189)} = .636, P > .05, \eta^2 = .003$ The effect size of 0.3% was negligible. Therefore, hypothesis 3 was not rejected.

Table 3. Scheffe post-hoc tests of post tests achievement scores according to treatment group

Treatment	N	Mean	Individualised reflective journal writing strategy	Cooperative reflective journal writing strategy	Conventional method
Individualised reflective journal writing (IRJWS)	90	18.175		*	*
Cooperative reflective journal writing (CRJWS)	50	19.127	*		*
Conventional method (CM)	68	10.667	*	*	

**Pairs of groups significantly different at $P < 0.05$*

Table 4. Estimated marginal means of post test achievement by verbal ability

Verbal ability	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
Low	14.89	.38	14.14	15.64
Medium	16.13	.49	15.16	17.09
High	17.50	.56	16.40	18.59

Table 5. Scheffe post-hoc tests analysis of post tests achievement scores according to verbal ability

Verbal ability	N	Mean	Low	Medium	High
Low	96	14.89		*	*
Medium	75	16.13	*		*
High	37	17.50	*	*	

Table 6. Estimated marginal means of students' achievement on gender

Gender	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
Male	16.39	.42	15.55	17.22
Female	15.95	.35	15.26	16.64

From Table 6, male students had a higher mean score of (\bar{x} = 16.39) than the Females (\bar{x} = 15.95), but the difference in their mean was not significant.

4. DISCUSSION

Cooperative reflective journal writing was more effective at improving students' achievement in biology than both individualised reflective journal writing and the conventional method. The effectiveness of cooperative reflective journal writing over both individualised reflective journal writing and the conventional method may be due to the fact that the strategy helped the students to collaborate and actively participate in their learning activities. Furthermore the effectiveness of the two modes of reflective writing may be attributed to the fact that these strategies promote reflection in students during learning. This was in agreement with the findings of [20,36,37].

The individualised reflective journal writing strategy was also found to be more effective than the conventional method. This may be as a result of the fact that it enables students to learn while they are writing. It allows each student to make a regular assessment of what they are doing in the classroom. They can check to see to what extent their assumptions about their own learning are reflected in their actual daily practices. This corroborates the findings of [38] that a cooperative learning strategy is more effective than an individualistic strategy or a conventional method.

There was a significant difference in achievement of students that belonged to low, Medium and high verbal ability. It could therefore be inferred verbal ability have a direct effect performance in Biology. This finding was in line with similar research works of [39] who reported that regardless of the quality of learning strategies used by the teacher, verbal ability has an effect on students' achievement.

The study showed that gender has no significant main effect on students' achievement. That is, gender had no influence on achievement. Our

findings disagrees with research findings of [27] and [29] that established significant differences of gender on students achievement. This finding is in mutual agreement with the findings of [28] and [40] which reported that there is no significant difference between male and female achievement in science. The implication of this is that irrespective of the students' gender, the achievement of students depends on the learning strategy employed.

5. CONCLUSION AND RECOMMENDATIONS

The right selection and appropriate use of instructional strategies may result in better achievement on the part of the learners. This study has shown that individualised reflective journal writing and cooperative reflective journal writing strategies were both more effective in improving the students' achievement in Biology over than the conventional method. In addition, the cooperative reflective journal writing strategy was more effective than the individualised reflective journal writing strategy. Hence, when students were allowed to reflect taking advantage of social dynamics of cooperative learning their achievement was better than when they reflect individually.

However, the two strategies can be used to foster the learning of selected concepts in Biology irrespective of gender. Verbal ability was influential likely because students' verbal ability plays a role in writing journals. Those with high verbal ability had more opportunity to express their thinking allowing the teacher to recognize their deficits and offers explanations. On the other hand those who could not adequately express their thoughts and reflections may not receive the help they needed resulting in poor performance.

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

- (1) There is need to popularize the use of both individualised reflective journal writing and cooperative reflective journal writing

- strategies among secondary school teachers in the teaching of Biology.
- (2) Teachers should be encouraged to use individualised reflective journal writing and cooperative reflective journal writing strategies to improve the achievement of their secondary school students in Biology teaching.
 - (3) Both individualised reflective journal writing and cooperative reflective journal writing strategies are recommended to secondary school Biology teachers for the teaching of Biology since both strategies are not gender bias.
 - (4) Government and professional bodies such as Science Teachers Association of Nigeria (STAN), National Teachers Institute (NTI) and the Nigerian Union of Teachers (NUT), should expose Biology teachers to the use of these strategies through seminars and workshops and in teacher training institutions to facilitate better performance of secondary school Biology students.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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