

Effectiveness of Think-Pair-Share strategies and Peer-Tutoring in improving students' Self-Efficacy and Science Process Skills in Biology

Akinbayo Temitope Oluwafemi¹, Oladipupo Popoola Oluwasegun¹, Owolade Adeyinka Olayemi² & Ariyo Oyeniyi Sunday³

¹Department of Science and Technology Education, Obafemi Awolowo University, Ile-Ife

²University of Ilesa, Ilesa

³Federal College of Education, Ilawe, Ekiti

Corresponding Author: akinbayooluwafemi@gmail.com

Abstract

The research examined the effectiveness of Think-pair-share and Peer-tutoring instructional strategies in enhancing self-efficacy and science-process skills of students in Biology. The study sample consists of SSS 2 students of Biology in Osun State. The simple random sampling technique was used to select three intact classes of 66 students from senior secondary schools in Osun State, and they were randomly assigned to the treatment groups: Think-Pair-Share Instructional Strategy (TIS), Peer-Tutoring Instructional Strategy (PIS), and Conventional Instructional Strategy (CIS). Biology Science Process Skills Rating Scale (BSPSRC) and the Students' Self-Efficacy Questionnaire (SSEQ) were the instruments used to obtain the data. Analysis of Covariance was used to test the significant differences between the groups. The findings indicated that there was statistically significant difference between the skills of students in the three groups on science process ($F=6.274$; $df=3$; $p<0.05$). Moreover, the results were statistically significant in showing a difference in self-efficacy among the students in the three groups. ($F=4.669$; $df=3$; $p<0.05$). Finally, the outcome indicated that there was a major difference in the science process skills ($F=4.623$; $df=3$; $p<0.05$) and Self-Efficacy ($F=4.548$; $df=3$; $p<0.05$) of students who were exposed to PIS, TIS and CIS in Biology. The research was able to conclude that, the teaching strategy of Think-Peer-Share and Peer Tutoring increased the learning outcomes of the students in Biology.

Keywords: Peer-Tutoring, Think-Pair-Share, Science Process Skills, Self-efficacy, Instructional strategies, Secondary Schools, Biology

Introduction

Science is crucial for the understanding of our environment. Science may be liberating in a forward-thinking, progressive culture, helping individuals break free from the cycle of superstition and ignorance. In any culture, science also serves as a tool for advancement in technology. Schmid & Bogner (2015) Since a nation's level of scientific progress influences its prestige, economic might, social influence, and political clout, science and technology are essential tools for a country's total sustainable development. In one instance, argued that a country's socio-economic political decisions cannot be expected to be rational if its citizens lack knowledge of science. According to Kareem (2022), education in science and technology can enable people to engage fully and intelligently in the productive sector of the economy, potentially

contributing to the growth of the country. As a result, countries keep working to ensure that scientific courses are taught in schools to achieve nation's goals.

NPE (2018) states that the primary purpose of science education implementation is to make students acquire a basic understanding and comprehension of scientific concepts, rules, and principles with the help of systematic study and understanding of data management. Activities like hypothesis testing, methodical experimentation, interpreting facts pertaining to hypotheses, and gaining a broader comprehension of the nature of science can all help to foster scientific thinking. Allowing students to explain scientific facts fosters their discovery process, broadens their comprehension of science learning, and improves their science process abilities. "In forming meaningful

learning and the development of various skills, elements of attitude and skills which is a basic process, which prove that fact that learning science is not only glued to the course in the form of cognitive thinking skills.” According to Ruiz-Martin and Bybee (2022), experiments and laboratory work makes science education real. Biology is listed as one of the subjects in specialized fields of study for science subjects by the NPE. It is an essential constituent of the sciences, which if neglected leads to a false and limited impression of the living world (Hipkins, 2012).

The natural science of biology examines the structure, functioning, development, and origins of the living world as well as the relationships between living organisms and their surroundings. In many scientific disciplines that significantly drives the nation’s technologically forward, it is considered as a necessary foundation. (Adam, 2021; Macfarlane et al., 2022).

There is no denying biology’s significance to humanity since it has improved the technological capabilities of humans, the plant and animal kingdoms, and the human race as a whole. Students who study Biology by making observations, analyzing data, and drawing conclusions are more likely to be able to solve environmental problems like pollution, UV rays, global warming, and environmental deterioration. Among other things, students learn how to observe, inquire, think critically, experiment, and reason logically (Idika, 2022)

Furthermore, biology gives students abilities that they can use in their chosen careers, according to Nnorum and Njideka (2022). It is undeniable that biology is extremely important. Despite its enormous importance, its teaching and learning methods have proven difficult throughout time. Over time, low self-efficacy and poor science process skills in biology have drawn more attention, leading academics to investigate some of the disease’s origins. Among the characteristics identified include teachers’ educational tactics, their lack of understanding of practical exercises, and their negative attitudes toward biology (Wai & Khine 2020; Mandasari, Iwan & Damopolii, 2021).

Students’ learning outcomes are improved when teachers use relevant and appropriate teaching resources and strategies. Since biology is a science subject, Biology teachers should use methods that will allow students to participate actively. Teachers should focus on the processes that occur during teaching and learning, as these processes are crucial for the development of students’ learning abilities. This may be realistic if science instructors use learner-centered

instructional strategies that encapsulate learners of different learning style preferences.

According to Mandasari et al. (2021), effective teachers don’t use a single approach. Rather, he or she employs whatever techniques and resources appear to be most appropriate for the unique combinations of each circumstance. Nnorum and Ndijeka (2020) noted in a related study that no approach is ideal for every teaching circumstance. They did, however, emphasize that learning may be made successful with a well-thought-out teaching strategy. According to Chukwu and Arokoyu (2017), the method’s effectiveness also hinges on a careful examination of the learning objective, the pupils in the class, the current curriculum, or the subject matter being taught.

For effective instruction, the teacher must create an environment that promotes meaningful interaction between themselves and learners throughout the instructional process. Teaching can be said to be effective when the aims, goals, and objectives of education have been achieved, and this is usually measured through various learning outcomes (Vladimirovna, 2022). Teaching and learning quality will be important in improving the understanding of basic concepts. Chukwuma and Abba (2020) define quality teaching as the ability of a teacher to move knowledge into effective pedagogical methods that can fit into the capacity of every student and the different backgrounds of the students, with the effectiveness of quality teaching measured in terms of learning outcomes.

Academic performance, process skills, self-efficacy, retention ability, and attitudes are examples of these learning outcomes. Science process skills will be mastered by students who have learned various cognitive skills from teachers’ various teaching methods (Darmaji, Kurniawan & Irdianti, 2019). The majority of science instructors still teach biology using the lecture approach rather than cutting-edge, student-centered demonstration techniques that are successful and outcome-oriented. Numerous teaching approaches, including collaborative learning strategies and result-oriented approaches like think-pair-share and peer tutoring, have been proposed with the goal of enhancing students’ scientific skills and confidence.

According to Hidayat, Nasir, Fadzli, Rusli, Kamaruzzaman, Yii Zi Sheng, and Shukeri, A. S. (2023), a peer-mediated approach in which students act as academic tutors, which shows peer tutoring is a flexible approach, pairing excellent students with their dull counterparts to review important academic or

behavioural concepts. A teaching technique that entails student collaborations, matching high performing students to the low performing students or those with the same achievement, is known as Peer tutoring, which is used for structured reading and study sessions. It is also a research-based strategy that encourages students to actively participate in class. According to Bamidele & Ogunleye, (2017), peer tutoring is a systematic, peer-mediated teaching strategy. It is additionally a research-based strategy that advances active commitment for students in the class.

Also, students collaborate to study or perform a task using the think-pair-share method of instruction. Frank Lyman created it to help pupils reflect on a particular subject. With this approach, students must consider a topic or respond to a question on their own and then present their thoughts to their peers (Oloyede, Bamidele & Oladipupo, 2021). Because of its simplicity, instructors may easily implement cooperative learning, and a variety of course structures can easily adopt it. Students think through questions using the following three steps;

Think- peer share instructor poses a question that aligns with the content. Students were allowed to think of the question on their own within the given period. Pair- students partner up with someone seated in proximity to discuss the solution to their answers and ask questions. Students pair up with a partner who will present a summary of their discussion to the larger group. They then reflect on how the responses shared by others have influenced or enhanced their own understanding of the topic. Think-pair-share and peer tutoring are two examples of intellectual techniques that rely on practical approaches to scientific education. The two instructional strategies existed on the fact that students learn when they are actively involved, rather than passively receiving knowledge, just like in the conventional lecture method. As supported by (Nwaukwa & Okolocha, 2020), these techniques enable students to collaborate to finish a task, build interpersonal and cognitive abilities, and cultivate metacognitive awareness. According to Kombat et al (2023), think-pair-share improves students' self-efficacy and engagement in mathematics classes. Also, Oloyede, Bamidele and Oladipupo (2021) posited in their research that the use of cooperative learning techniques like thinking, pairing and sharing enhanced the learning performance of students who took chemistry. However, much is yet to be done on Biology in this regard.

One of the science learning outcomes that is valuable and helpful to the science learner in handling scientific activities and constructing scientific material, is the scientific skills. The skills needed in real-life classrooms in thinking and carrying out investigations are called Science Process Skills (SPS) (Çakir and Sarikaya, 2010; Patresia, Silitonga and Ginting 2020). They may be regarded as simple skills that may be utilized in inquiry (Handayani, Adisyahputra, and Indrayanti, 2018). Along with the better mastery of skills, the scientific skills development will also contribute to the mastering of scientific information. Scientific inquiry is highlighted as an essential part of the formation of scientific skills due to the assumption that skills in the process of science create the environment in which thinking and learning new information become possible (Kareem, 2022). Children need a set of mental and physical abilities known as SPS in order to comprehend science and to solve social and personal issues. Such skills are used to build up one's skills, educate students during the learning process, and use the skills to address problems in everyday life (Ozturk, Tezel, and Acat, 2010). Rahayu, Pratiwi, and Indana (2018) suggest that science process skills are necessary to promote science literacy to enable an individual to tackle challenging issues in science and technology, which have arisen over the recent years. Sadly, studies have shown that a lot of teachers find the science process difficult (Artayasa, Susilo, Lestari & Indriwati 2017). This results from a lack of ability to develop and execute studies (Sukarno, Hamidah, Widodo & Budhj, 2013).

The concept of self-efficacy emanates from the social cognitive theory of Albert Bandura, it explains human functioning as the result of continuous interactions among environmental, behavioral, and personal factors (Bandura, 1997, 2012). The confidence and assertion that one can successfully thrive in a situation or complete a job is known as self-efficacy. It significantly affects how driven, industrious, and tenacious kids are in their academic endeavors. If students first believe and have confidence that they can carry out a task without uncertainty, anxiety, or pessimism, learning objectives will be easily met (Hidayati, Leny & Iriani, 2018). Pupils with so much confidence that they can complete a given assignment are quick to adopt behavioral practices that improve their ability to complete the tasks at hand, such as employing effective learning strategies. This is due to the fact that students who are so much confident about performing a task can see setbacks and difficulties as

chances for improvement and learning rather than threats to their capabilities, while their counterparts who are timid at completing any given assignment tend to abscond difficulties and quit quickly. Hence, constructive teacher evaluation is important in reinforcing a student self-confidence (Bandura, 1997).

The dynamic interplay of personal, behavioral, and contextual variables is a characteristic of human functioning within and outside of formal classroom settings (Maddux, 2016). According to studies, those who engage in cognitive activities do better, which boosts their sense of self-efficacy (Farmer, Xu & Dupre, 2022). Albert Bandura posited that self-efficacy is the belief an individual has in their own talents, which consequently affects how well they perform in a learning environment (Farmer, Xu, & Dupre, 2022). People's feelings, thoughts, and behaviors are influenced by their self-efficacy beliefs. One of the most crucial elements for success, self-efficacy influences various facets of learning behavior, such as activity choice, effort, and perseverance in learning and advancement (Ahmed, Lawal & Ahmed, 2022).

Facilitating and encouraging maximal learning engagement is the primary goal of classroom interaction. Students typically exhibit higher levels of interest and participation in lessons when they connect in the classroom, which improves performance (Hentges, 2016). The TIS and PIS positive task interdependence made possible by instructional strategies aids in the growth and development of students' self-esteem, critical thinking, and personal traits. According to earlier researches, students' scientific skills and self-efficacy in biology are unimpressive. These poor learning outcomes were caused by students' distaste for science, low self-efficacy, their ignorance of and inability to interpret experimental setups, and the inefficient teaching strategies used by teachers in the classroom (Uzezi & Zainab, 2017, Kareem 2022). Many approaches have been developed to teach this subject, including think-pair-share and peer tutoring, which are self-regulated learning techniques for students. Learning results have been demonstrated to benefit from the use of think-pair-share and peer tutoring techniques. Because they must read and prepare for the lessons, students gain a deeper understanding of the material (Chianson, Aligba & Jimin 2015; Ullah, Tabassum and Kaleem, 2018; Oloyede et al, 2021). They also benefit from the lesson as they share knowledge and lessons learned. Peer tutoring is a strategy of learning that teaches students to work in groups with their peers, this

enhances their knowledge and learning skills, according to Longjohn (2022). Similar to this, Ifamuyiwa & Onakoya (2013) and Oloyede et al. (2021) viewed TIS as a way to teach mathematics and chemistry in which students are arranged in pairs to exchange knowledge and maximize mutual advantages. However, there hasn't been much literature on the effectiveness of the two methods for assessing biology students' self-efficacy and science process skills. Consequently, the main aim of the study is to find out how well think-pair-share and peer tutoring instructional strategies work to raise biology students' self-efficacy and science process abilities.

Research Questions

The following research questions were raised.

- Is there a difference in the students' science process skills using PIS and TIS?
- Is there a difference in the students' self-efficacy using PIS and TIS?

Research Hypothesis

H₀₁: Is there a significant effectiveness in the students' science process skills using PIS and TIS?

H₀₂: Is there a significant effectiveness in the students' students' self-efficacy using PIS and TIS

H₀₃: Is there a significant effectiveness in the students' science process skills and self-efficacy using PIS and TIS.

Methodology

Research Design

This study adopted the quasi-experimental research design, which was the non-equivalent pretest, posttest. In this research, there were three research groups.

(Experimental group A)	O _A	X _A	O _B
(Experimental group B)	O _C	X _B	O _D
(Control group C)	O _E	X _C	O _F

Where

O_A, O_C and O_E are the pretest for the 2 experimental groups and control, which are respectively. O_B, O_D, O_F are the post-test for the 2 experimental groups and control, which are respectively. (X_A) was exposed to PIS, (X_B) was exposed to TIS. Finally, (X_C) was taught using CIS. The variables in the study were independent (PIS, CIS and CIS); the dependent variables were students' science process skills and self-efficacy.

Population

The study population consisted of all senior secondary school students (SSS) who study Biology in Osun State.

Sample and Sampling Technique

The study sample was composed of 66 SSS 2 Biology students in their regular classes. The sampling of the research was done using a multi-stage sampling procedure. There were three educational districts in the state, and the simple random sampling was used to select an educational district. One Local Government Area (LGA) was selected by use of the simple random sampling technique among the educational district that was selected. Moreover, the simple random sampling technique was used to select three schools in the chosen LGA, and the schools were randomly divided into two experimental groups and a control group.

Research Instruments

The following research instruments were employed for the study: Biology Science Process Skills Rating Scale (BSPSRCS) and Students' Self-Efficacy Questionnaire (SSEQ).

The BSPSRCS was deployed to examine the students' science process skills in Osun state. It consisted of two sections; namely A and B. Section A elicited responses on students' demographic information and section B consisted of 9 items on students' process skills in Biology which includes nine aspects of evaluation (indicators), namely: Observation, Measuring, Classification, Communication, Inference, Formulating hypotheses, Performing experiment, Defining variables operationally, and Interpretation of data. The responses were rated Excellent, Very Good, Good, Fair and Poor, which were respectively numbered 5, 4, 3, 2, and 1.

The Students' Self-Efficacy Questionnaire (SSEQ) was applied to assess the confidence of students in biology classrooms and the students' self-efficacy. It was divided into two sections: Section A and Section B. Section A collected personal information of the respondents, such as school name, sex, and age; Section B is made up of 17 items which measure the students' self-efficacy in Biology. This section was designed using a 4-point Likert scale, Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) with the corresponding marks of 4, 3, 2, and 1 respectively.

The instruments were also validated by the opinion of the supervisor of the researcher and three experts; one was a member of the Department of

Science and Technology Education, another was a member of the Department of Test and Measurement, Obafemi Awolowo University, Ile-Ife, and the final member was a Biology teacher in one of the schools in the state.

After modifications based on expert corrections and vetting, trial testing of the instrument was carried out by administering the instruments on 30 senior secondary school students in a selected school in a LGA outside the study area, and the data obtained were used to determine its reliability. The split-half reliability test was used to determine the instruments' coefficient value and Spearman-Brown's unequal length coefficient value 0.84 was obtained for BSPSRCS. Also, the reliability of the BSEQ was obtained using the Cronbach alpha coefficient which revealed a value of 0.735. Split-halves value obtained were 0.457 and 0.620 for first and second halves respectively, and 0.814 for the Spearman-Brown Coefficient.

Procedure for Data Collection

The school authorities were consulted before the study was conducted. The experimental group A was subjected to the PIS, experimental group B was also subjected to TIS and the control group was subjected to CIS. The Cell and its Environment was what was taught. The process was divided into three phases, namely, pre-treatment, treatment, and after-treatment. The BSPSRCS and SSEQ were conducted at the pre-treatment stage to determine the skills of the students in the science process and self-efficacy in Biology. One week later, the treatment phase started and four weeks were devoted to it. In this phase, PIS, TIS and CIS groups were instructed in one group, respectively. The post-treatment phase began immediately after the treatment phase. The BSPSRCS was again administered at this stage in the students in their practical classes to evaluate the science process skills in Biology and the researcher participated in observation. The post-treatment SSEQ was also done.

Data Analysis

Standard deviation, mean, and Analysis of Covariance (ANCOVA), were employed to analyse data. Scheffe posthoc analysis was also done to know how the significance varies.

Results

The results were presented by testing the Hypothesis stated based on the research objectives. Data related to objective one was tested using descriptive analysis and

Analysis of Covariance (ANCOVA) as discussed below.

Research Question 1

Is there a difference in the students' science process skills using peer tutoring and think-pair-share instructional strategies?

To answer this research question, data collected on students' science process skills after exposure to PIS, TIS, and CIs were subjected to descriptive statistics. The result is presented in Table 1 below:

Table 1: Mean and standard deviation of students' post-test scores within various treatment and conventional groups in science process skills

	Strategies	N	\bar{x}	SD
1.	PIS	25	36.04	3.94
2.	TIS	21	34.48	5.39
3.	CIS	20	31.50	3.28
Total		66	34.17	4.63

N = 66

Table 1 illustrates that the number of participants who were classified as PIS was 25, TIS was 21 and CIS was 20. In addition, it was observed that students' science process skills vary when Biology was taught through PIS, TIS and CIS in senior secondary schools in Osun State, that the mean performance of the participants in the groups is as follows: those in PIS group had a mean score of ($\bar{x} = 36.04, \pm = 3.94$), those in the TIS group had a mean score of ($\bar{x} = 34.48, \pm = 5.39$), and those students in the CIS group had a mean score of ($\bar{x} = 31.50, \pm = 3.28$).

Hypothesis One:

Is there a significant effectiveness in the students' science process skills taught Biology with PIS and TIS in senior secondary schools in Osun state.

To verify this hypothesis, Analysis of covariance (ANCOVA) and Scheffe post hoc analysis were used to analyse data regarding the students' science process skills exposed to PIS, TIS, and CIS. In this study, the dependent variable was post-test science process skills scores, and the independent variable was pre-test science process skills scores. Tables 2 and 3 present the results.

Table 2: Analysis of covariance of the difference in the science process skills of students using PIS and TIS in Biology

Tests of Between-Subjects Effects						
Dependent Variable: Post Science Process Skills						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	234.601 ^a	3	78.200	4.192	.009	.169
Intercept	2029.688	1	2029.688	108.805	.000	.637
PreSPS	2.633	1	2.633	.141	.708	.002
Strategies	234.074	2	117.037	6.274	.003	.168
Error	1156.565	2	18.654			
Total	78437.000	66				
Corrected Total	1391.167	65				

R Squared = .169 (Adjusted R Squared = .128)

(F = 6.274; $p < 0.05$)

As seen from the test output in Table 4, it is noted that the $F_{cal} = 6.274$; $p < 0.05$ at the .05

significant level, and that 16.8% (eta of 0.168) of the variance in the science process skills of the students was

due to their presence in the treatment groups. Subsequently, the stated null hypothesis was rejected, indicating that there is a significant difference in the students' science process skills taught biology using PIS and TIS. This means that there is a significant difference in the effectiveness of PIS and TIS in improving the science process skills of biology students in Osun State. At the group level, this suggests that the group

members' exposure to PIS, TIS or CIS, respectively, can account for the variation in students' science process skills.

After detecting a significant difference among the groups, further analysis was conducted to determine the direction of this difference in science process skills by subjecting the data to Scheffe post-hoc analysis. The result is presented in Table 3 below.

Table 3: Scheffe post hoc analysis of the difference in science process skills of students using PIS and TIS in Biology

Multiple Comparisons						
Dependent Variable: Post Science Process Skills						
Scheffe						
(I) Strategies	(J) Strategies	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
PIS	TIS	1.5638	1.26972	.473	-1.6195	4.7471
	CIS	4.5400*	1.28686	.003	1.3137	7.7663
TIS	PIS	-1.5638	1.26972	.473	-4.7471	1.6195
	CIS	2.9762	1.34022	.007	-.3839	6.3363
CIS	PIS	-4.5400*	1.28686	.003	-7.7663	-1.3137
	TIS	-2.9762	1.34022	.007	-6.3363	.3839

Based on observed means.

The error term is Mean Square (Error) = 18.400.

The mean difference is significant at the .05 level.

Table 3 presents the Scheffe post-hoc analysis of the differences in students' science process skills when taught Biology using PIS and TIS in senior secondary schools in Osun state. The table indicates that the mean score difference between students exposed to PIS and those taught with TIS is 1.563, with $p=0.47$ at the .05 sig level showing that neither group outperformed the other. Similarly, the mean score difference between PIS and CIS is 4.54, with $p= 0.00$ indicating that students in PIS group outperformed CIS. Furthermore, the mean score difference between TIS

and CIS is 2.976, with $p= 0.00$ with TIS showing better performance. Overall, this implies that PIS are effective in improving students' science process skills in Biology.

Research Question Two:

Is there a difference in the students' self-efficacy using PIS and TIS?

To answer this research question, data collected on students' self-efficacy after exposure PIS, TIS, and CIS were subjected to descriptive statistics. The result is presented in table 4 below:

Table 4: Mean and standard deviation of students in pre-test and post-test within various treatment and conventional groups in self-efficacy

S/N	Strategies	N	\bar{x}	SD
1.	PIS	25	45.00	8.44
2.	TIS	21	42.62	7.53
3.	CIS	20	37.95	7.05
Total		66	42.14	8.19

N = 66

Table 4 shows that 25 participants belonged to the PIS group, 21 to the TIS group, and 20 to the CIS

group. Furthermore, it was noted that there are variations in students' self-efficacy when Biology was

taught using Peer-Tutoring, Think-Pair-Share, and Conventional Instructional Strategies in senior secondary schools in Osun State. that the mean performance of participants in the groups is such that those in the PIS group achieved a mean score of ($\bar{x} = 45.00, \pm = 8.44$), the TIS had a mean score of ($\bar{x} = 42.62, \pm = 7.53$), and those in the CIS group had a mean score of ($\bar{x} = 37.95, \pm = 7.05$).

Hypothesis Two:

Is there a significant effectiveness in students' self-efficacy when Biology is taught using PIS and TIS in senior secondary schools in Osun state.

To test this hypothesis, data on students' self-efficacy after exposure to PIS, TIS, and CIS were subjected to Analysis of Covariance (ANCOVA), and Scheffe post-hoc analysis. In this analysis, post-test science process skills scores were used as the dependent variable, while pre-test science process skills scores served as the independent variable. The results are presented in Tables 5 and 6.

Table 5: Analysis of covariance (ANCOVA) of the difference in the self-efficacy of students using peer-tutoring and think-pair-share instructional strategies in Biology

Tests of Between-Subjects Effects							
Dependent Variable: Post Self-efficacy							
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Squared	Eta
Corrected Model	590.138 ^a	3	196.713	3.235	.028	.135	
Intercept	4228.942	1	4228.942	69.554	.000	.529	
PreSE	18.107	1	18.107	.298	.587	.005	
Strategies	567.745	2	283.873	4.669	.013	.131	
Error	3769.635	62	60.801				
Total	121541.000	66					
Corrected Total	4359.773	65					

R Squared = .135 (Adjusted R Squared = .094)

(F = 4.669; p < 0.05)

As seen from the ANCOVA test output in Table 5, it can be noted that the $F_{cal} = 4.669$; $p < 0.05$ at the .05 significant level, and that 13.1% (eta of 0.131) of the variance in the self-efficacy of the students was due to their presence in the treatment groups. Subsequently, the null hypothesis was rejected, indicating that there is a significant difference in the students' science process skills taught biology using PIS and TIS. This means that there is a significant difference in the effectiveness of PIS and TIS in improving the self-efficacy of biology

students in Osun State. At the group level, this suggests that the group members' exposure to PIS, TIS or CIS, respectively, can account for the variation in students' science process skills.

After detecting a significant difference among the groups, further analysis was conducted to determine the direction of this difference in self-efficacy by subjecting the data to Scheffe post-hoc analysis. Result is presented in table 6 below.

Table 6: Scheffe post hoc analysis of the difference in the self-efficacy of student using PIS and TIS in Biology

Multiple Comparisons						
Dependent Variable: Post Self Efficacy Scores						
Scheffe						
(I) Strategies	(J) Strategies	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
PIS	TIS	2.4610	2.29519	.566	-3.2934	8.2153
	CIS	7.1300*	2.32617	.013	1.2980	12.9620
TIS	PIS	-2.4610	2.29519	.566	-8.2153	3.2934
	CIS	4.6690	2.42263	.025	-1.4048	10.7429
CIM	PIS	-7.1300*	2.32617	.013	-12.9620	-1.2980
	TIS	-4.6690	2.42263	.025	-10.7429	1.4048

Based on observed means.

The error term is Mean Square (Error) = 60.123.

The mean difference is significant at the .05 level.

Results in Table 6 present the Scheffe post-hoc analysis of differences in students' self-efficacy when taught Biology using Peer-Tutoring, Think-Pair-Share, and Conventional Instructional Strategies in senior secondary schools in Osun State. The table indicates that the students' self-efficacy taught with PIS was significantly higher than those taught with CIS (Mean Difference = 7.1300; $p < 0.05$). Similarly, a significant difference was observed between students taught with TIS and CIS (Mean Difference = 4.6690; $p < 0.05$). However, there was no significant difference in self-efficacy between students exposed to PIS and those taught with TIS Mean Difference = 2.461; $p = 0.56$ at .05 level of significance, implying that neither group outperformed the other. This implies that the PIS and

CIS had the greatest impact on students' self-efficacy in Biology, followed CIS.

Hypothesis Three:

Is there a significant effectiveness in the self-efficacy and students' science process skills taught Biology with PIS and TIS in senior secondary schools in Osun state. In order to test this hypothesis, the Multivariate Analysis of Covariance (MANCOVA) was used to analyze the post-science process skills and self-efficacy scores of students taught using PIS, TIS and CIS. Here, the dependent variables were the post-science process skills and self-efficacy scores, whereas pre-science process skills and self-efficacy scores were considered as the independent variables. Table 7 shows the results.

Table 7: Multivariate analysis of covariance (MANCOVA) of the difference in the science process skills and self-efficacy of students using PIS and TIS in Biology

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
HiCorrected Model	PostSPS	243.787 ^a	4	60.947	3.240	.018	.175
	Post SE	643.461 ^b	4	160.865	2.640	.042	.148
Intercept	PostSPS	1086.185	1	1086.185	57.747	.000	.486
	Post SE	1515.507	1	1515.507	24.876	.000	.290
PreSPS	PostSPS	3.131	1	3.131	.166	.685	.003
	Post SE	53.324	1	53.324	.875	.353	.014
PreSE	PostSPS	9.185	1	9.185	.488	.487	.008
	Post SE	21.240	1	21.240	.349	.557	.006
Strategies	PostSPS	173.916	2	86.958	4.623	.014	.132
	Post SE	554.103	2	277.051	4.548	.014	.130
Error	PostSPS	1147.380	61	18.810			
	Post SE	3716.311	61	60.923			

Total	PostSPS	78437.000	66
	Post SE	121541.000	66
Corrected Total	PostSPS	1391.167	65
	Post SE	4359.773	65
R Squared = .175 (Adjusted R Squared = .121)			
R Squared = .148 (Adjusted R Squared = .092)			

Science process skills ($F = 4.623$; $p < 0.05$); Self-efficacy ($F = 4.548$; $p < 0.05$).

Results in Table 7 revealed there exists a significant difference in the science process skills ($F = 4.623$; $p = 0.14$) and self-efficacy ($F = 4.548$; $p = 0.14$) of students when they were taught using peer-tutoring, think-pair-share and conventional teaching strategies in Biology in senior secondary schools in Osun State. Therefore, the null hypothesis was rejected.

Discussion of Results

The results revealed a significant difference in students' science process skills across the three instructional strategies. Pairwise mean comparisons showed that PIS was very effective, followed by the TIS, while the CIS had the least effect. These findings corroborate Osei and Appiah Twumasi (2018), who reported that cooperative learning strategies significantly enhance students' understanding of science concepts. Cooperative learning has also been linked to the development of higher-order thinking skills through active peer interaction (Johnson, Johnson, & Smith, 2014). Similarly, Parker and Asare (2021) found that the think-pair-share technique enables learners to acquire skills at their own pace, further reinforcing the effectiveness of interactive instructional approaches.

Results from hypothesis two revealed a significant difference in students' self-efficacy when taught Biology using PIS, TIS, and CIS in senior secondary schools in Osun State. Pairwise mean score comparisons showed that students exposed to PIS demonstrated the highest self-efficacy, followed by those taught with TIS, while the CIS ranked lowest.

Theoretically, this finding aligns with Vygotsky's (1978) theory of social interaction and learning, which emphasizes that children's cognitive development is shaped not only by their interactions with objects but also through engagement with more knowledgeable peers and adults. Through such interactions, learners develop self-efficacy as they perform tasks independently, often with a peer acting as a facilitator. Students are further motivated when they observe their peers' successes, encouraging them to

aspire to similar or greater achievements, and in some cases, take on leadership roles as peer-leaders.

This result is consistent with Saunders-Wyndham and Smith (2020), who found that cooperative learning increased students' self-efficacy, though no single classroom factor was identified as responsible for this effect. Similarly, Fernandez-Rio, *et al* (2017) reported that cooperative learning was more effective than conventional methods in enhancing students' academic self-efficacy. The findings also align with Falebita and Olofin (2020), whose study revealed that the TIS significantly improved students' self-efficacy in learning circle geometry. According to their findings, TPS promoted stronger self-dispositions compared to conventional strategies, likely due to its interactive nature, which encourages learners to engage with peers, exchange ideas, and receive guidance from teachers

The study demonstrated that students' science process skills and self-efficacy varied significantly when taught using PIS, TIS and CIS in Biology at the senior secondary level in Osun State. This outcome corroborates Adagwine's (2023) research in Jordan, which established that students exposed to TIS outperformed their peers taught with conventional methods such as discussion. In the same vein, Parker and Asare (2021) noted that think-pair-share not only facilitates the acquisition of skills at learners' individual pace but also promotes academic achievement and independence in learning. Consistently, Tindal and Godfred (2024) discovered that the strategy exerted a significant positive influence on students' learning outcomes in Chemistry.

Conclusion and Recommendations

In this study's findings, it was inferred that PIS and TIS enhance students' learning outcomes in Biology. The strategies were also found to be effective in improving Biology students' science process skills and self-efficacy. Consequently, the study recommended that the use of Peer Tutoring and Think-Pair-Share should be promoted in science teaching to

enable learners to take responsibility for their own learning. Furthermore, science instructors should undergo regular training and retraining through workshops and seminars to effectively apply cooperative instructional strategies such as Peer Tutoring and Think-Pair-Share in their teaching. The study also suggested that these strategies be incorporated into science classrooms, including laboratories, to further enrich students' learning experiences.

References

- Abramczyk, A., & Jurkowski, S. (2020). Cooperative learning as an evidence-based teaching strategy: What teachers know, believe, and how they use it. *Journal of Education for Teaching*, 46(3), 296-308.
- Adagwine, P. A. (2023). The effect of think-pair-share teaching strategy on the academic performance of students in selected topics in Integrated Science. (Doctoral dissertation, University of Education, Winneba)
- Adam, R. D. (2021). Giardia duodenalis: biology and pathogenesis. *Clinical microbiology reviews*, 34(4), e00024-19.
- Ahmed, M. A., Lawal, A. A., & Ahmed, R. A. (2022). Influence of teachers' self-efficacy on secondary school students' self-efficacy in biology in Ogbomoso, Nigeria. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 8(1), 58-64.
- Aladejana, F. O. (2008). Blended learning and improved biology teaching in the Nigerian secondary schools. In Proceedings of the World Congress on Engineering and Computer Science. (pp. 22-24).
- Andrews, T. (2012). What is social constructionism? *Grounded theory review*, 11(1).
- Artayasa, I. P., Susilo, H., Lestari, U., & Indriwati, S. E. (2017). The Effectiveness of the Three Levels of Inquiry in Improving Teacher Training Students' Science Process Skills. *Journal of Baltic Science Education*, 16(6), 908-918.
- Bamidele, A. D., & Ogunleye, B. O. (2017). Effects of two modes of peer tutoring instructional strategies On senior secondary school students' acquisition of skills in chemistry practical. *NOUN Journal of Education*, 4, 186-195.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.
- Bandura, A. (2012). On the functional properties of perceived self-efficacy revisited. *Journal of management*, 38(1), 9-44.
- Çakır, N. K., & Sarıkaya, M. (2010). An evaluation of science process skills of the science teaching majors. *Procedia-Social and Behavioral Sciences*, 9, 1592-1596.
- Chianson, M. M., Aligba, S. O., & Jimin, N. (2015). Prevalent Learning Style among Secondary School Mathematics Students and Its Influence on Gender and Age in Benue State, Nigeria. *International British Journal of Applied Science and Technology*, 8 (4), 38, 399.
- Chukwu, J., & Arokoyu, A. (2017). Biology teacher's methods of teaching and academic performance of secondary school students in Abia State, Nigeria. *Journal of Emerging trends in Educational Research and policy studies*, 8(4), 228-231.
- Chukwuma, M. O., & Abba, D. N. (2020). Effective teaching and learning of biology at senior secondary school and crisis on its curriculum. *STEM Journal of Anambra STAN*, 3(1), 65-79.
- Darmaji, D., Kurniawan, D. A., & Irdianti, I. (2019). Physics Education Students' Science Process Skills. *International Journal of Evaluation and Research in Education*, 8(2), 293-298
- Falebita, O. S., & Olofin, S. O. (2020). Effects of think-pair-share (tps) learning strategy on senior secondary school students' performance and self-efficacy in circle geometry. *AAUA Journal of Science and Technology Education*, 3(1), 12-24.
- Farmer, H., Xu, H., & Dupre, M. E. (2022). Self-efficacy. In *Encyclopedia of Gerontology and Population Aging* (pp. 4410-4413). Cham: Springer International Publishing.
- Fernandez-Rio, J., Cecchini, J. A., Méndez- Gimenez, A., Mendez-Alonso, D., & Prieto, J. A. (2017). Self-regulation, cooperative learning, and academic self-efficacy: Interactions to prevent school failure. *Frontiers in psychology*, 8, 22.
- Galloway, A. (2015). Bringing a Reggio Emilia inspired approach into higher grades-Links to 21st century learning skills and the maker movement.
- Handayani, G., Adisyahputra, A., & Indrayanti, R. (2018). Correlation between integrated

- science process skills, and ability to read comprehension to scientific literacy in biology teachers and students. *Biosfer: Jurnal Pendidikan Biologi*, 11(1), 22-32.
- Hentges, J. (2016). Engaging Students in the Learning Process: What is the Best Practice? *Global Education Journal*, 2016(3).
- Hidayat, R., Nasir, N., Fadzli, S. A. M., Rusli, N. S., Kamaruzzaman, N. N., Yii Zi Sheng, V., & Shukeri, A. S. (2023). Peer Tutoring Learning Strategies in Mathematics Subjects: Systematic Literature Review. *European Journal of Educational Research*, 12(3).
- Hidayati, N., Leny, L., & Iriani, R. (2018). Pengaruh Model Pembelajaran Inquiry Based Learning dengan Pendekatan Flipped Classroom terhadap Self Efficacy dan Hasil Belajar Kesetimbangan Ion dalam Larutan Garam.
- Hipkins, R. (2012). Building a science curriculum with an effective nature of science component. *New Zealand Council for educational Research, Ministry of Education*.
- Idika, M. I. (2022). A Survey of The Awareness and Practice of Systems Thinking Approach among Chemistry Teachers in Southwest Nigeria. *Benin Journal of Educational Studies*, 28(1), 151-160.
- Ifamuyiwa, A. S., & Onakoya, S. K. (2013). Impact of think-pair-share instructional strategy on students' achievement in secondary school mathematics. *Journal of Science Teachers Association of Nigeria (JSTAN)*, 48(1), 26-34.
- Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on excellence in college teaching*, 25 (3&4).
- Kareem, A. (2022). Higher-Order Thinking Skills and Scientific Attitudes Components as Predictors of Scientific Creativity among Preservice Biology Teachers. *International Journal of Progressive Education*, 18(4), 21-30.
- Kombat, A., Asigri, V. N., Amanyi, C. K., Atepor, S., Adugbire, J. A., Akwensi, V. K., & Apari, M.B. (2023). Determining the most effective stage of the Think-Pair-Share teaching strategy. *British Journal of Education, Learning and Development Psychology*, 6(3), 7-24.
- Leidner, D. E., & Jarvenpaa, S. L. (1995). The use of information technology to enhance management school education: A theoretical view. *MIS quarterly*, 265-291.
- Macfarlane, N. B., Adams, J., Bennett, E. L., Brooks, T. M., Delborne, J. A., Eggermont, H., & Redford, K. H. (2022). Direct and indirect impacts of synthetic biology on biodiversity conservation. *science*, 25(11)
- Maddux, J. E. (2016). Self-efficacy. In *Interpersonal and intrapersonal expectancies* pp. 41-46). Routledge.
- Mandasari, F., Iwan, I., & Damopolii, I. (2021). The relationship between science process skills and biology learning outcome. *JISTECH: Journal of Information Science and Technology*, 1(1), 23-32
- Nnorom, N. R., & Njideka, E. M. (2022). Achieving employability and competitiveness through innovation practice in biology education. *COOU Journal of Educational Research*, 7(1).
- Nwaukwa, F. C., & Okolocha, C. C. (2020). Effect of think-pair-share instructional strategy on students' academic achievement and self-efficacy in financial accounting in Abia State. *International Journal of Recent Innovations in Academic Research*, 4(1), 37-48.
- O'loughlin, M. (1992). Rethinking science education: Beyond Piagetian constructivism toward a sociocultural model of teaching and learning. *Journal of research in science teaching*, 29(8), 791-820.
- Oloyede, M. A., Bamidele, E. F., & Oladipupo, P. O. (2021). Determination of Relative Effectiveness of Peer Tutoring and Think-Pair-Share Strategies in Improving Senior Secondary School Students' Academic Performance in Chemistry in Osogbo. *New Visions in Science and Technology Vol. 8*, 78-90.
- Osei, J. K., & Appiah-Twumasi, E. (2018). Cooperative Learning Strategy: Effective Student-Centered Intervention to Enhance Performance and Knowledge Retention. *International Journal of Innovative Research and Advanced Studies (IJIRAS)*, 5(5), 151-156.
- Öztürk, N., Tezel, Ö., & Acat, M. B. (2010). Science process skills levels of primary school seventh grade students in science and technology lesson. *Journal of Turkish Science Education*, 7(3), 15-28.
- Parker, J., & Asare, I. (2021). Teacher trainees' perceptions of think-pair-share technique in teaching classification of living organisms in



- colleges of education–Ghana. *Science Education International*, 32(4), 368-373.
- Patresia, I., Silitonga, M., & Ginting, A. (2020). Developing Biology Students' Worksheet Based on STEAM to Empower Science Process Skills. *Journal of Biological Education Indonesia (Jurnal Pendidikan Biologi Indonesia)*, 6(1), 147-156.
- Rahayu, Y. S., Pratiwi, R., & Indana, S. (2018). Development of biology student worksheets to facilitate science process skills of student. In *IOP Conference Series: Materials Science and Engineering* (Vol.296, No.1, p.012044). IOP Publishing.
- Ruiz-Martín, H., & Bybee, R. W. (2022). The cognitive principles of learning underlying the 5E Model of Instruction. *International Journal of STEM Education*, 9(1), 21.
- Saunders-Wyndham, J., & Smith, E. (2020). The effects of cooperative learning on self-efficacy in an EFL classroom. *JALT Journal*, 42(2), 121-142.
- Schmid, S., & Bogner, F. X. (2015). Effects of students' effort scores in a structured inquiry unit on long-term recall abilities of content knowledge. *Education Research International*, 2015(1), 826734.
- Sukarno, A. P., Hamidah, I., Widodo, A., & Budhi, J. S. (2015). The Analysis of Science Teacher Barriers in Implementing of Science Process Skills (Sps) *Teaching Approach at Junior High School and It's Solutions*.
- Tindan, T. N., & Godfred, T. (2024). Comparative Study on Think-Pair Share and Jigsaw Methods of Teaching Chemistry among SHS Students in Ghana. *International Journal of Latest Technology in Engineering, Management & Applied Science*, 13(4), 172-175
- Ullah, I., Tabassum, R., & Kaleem, M. (2018). Effects of peer tutoring on the academic achievement of students in the subject of biology at secondary level. *Education Sciences*, 8(3), 112.
- Uzezi, J. G., & Zainab, S. (2017). Effectiveness of guided-inquiry laboratory experiments on senior Secondary school students' academic achievement in volumetric analysis. *American Journal of Educational Research*, 5(7), 717-724.
- Vladimirovna, A. E. (2022). Innovative methods of teaching biology in secondary school. *American Journal of Interdisciplinary Research and Development*, 11, 243-250.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (Vol.86). Harvard university press.
- Wai, H. O., & Khine, S. S. (2020). An investigation into the difficulties of students in learning biology. *J. Myanmar Acad. Arts Sci*, 18(9), 183-197.