

EFFECTIVENESS OF REFLECTIVE- RECIPROCAL TEACHING ON PRE-SERVICE TEACHERS' ACHIEVEMENT AND SCIENCE PROCESS SKILLS IN INTEGRATED SCIENCE

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DIFFERENTIAL EFFECTIVENESS OF REFLECTIVE- RECIPROCAL TEACHING AND REFLECTIVE-
RECIPROCAL PEER TUTORING ON PRE-SERVICE TEACHERS' ACHIEVEMENT AND SCIENCE PROCESS
SKILLS IN INTEGRATED SCIENCE

ABSTRACT

Low level of achievement of pre-service teachers in Integrated Science at Colleges of Educations, led to the conceptualization of this research. Reflective-reciprocal teaching and reflective-reciprocal peer tutoring strategies have not been given much attention at college of education level where teachers are been trained for primary school grades. This study, therefore, investigates differential effectiveness of reflective- reciprocal teaching and reflective- reciprocal peer tutoring on pre-service teachers' achievement and science process skills in integrated science.

The pretest- posttest, control groups, quasi experimental design with a 3x2x3 factorial matrix was used. Two hundred and ninety-four (294) pre-service science teachers with high, medium and low numerical ability constituted the sample. Six instruments used were: Pre-service Teachers Achievement Test ($\alpha = 0.85$); Pre-Service Teacher Science Process Skills Rating Scale (Scott's π), Pre-Service Teacher Numerical Ability Test ($\alpha = 0.79$); stimulus instruments as operational guides for lecturers using the two treatments and control groups. Four Null hypotheses were tested at 0.05 level of significance. Data were analyzed using descriptive statistics.

The treatment had a significant main effect on pre-service teachers' achievement in integrated science concept ($F_{2,294} = 56.149$; $P < .05$) and science process skills acquisition ($F_{(2,294)} = 33.525$, $P < 0.05$). Pre-service Science Teachers exposed to RRPT attained higher achievement mean score ($\bar{x} = 24.8$) than those in the RRT ($\bar{x} = 21.02$) and control group ($\bar{x} = 18.891$). Also, for Science Process skills, the RRT group had higher mean score ($\bar{x} = 57.50$), than those in the RRPT ($\bar{x} = 49.28$) and the control groups ($\bar{x} = 47.04$).

The Reflective-Reciprocal Teaching as well as the Reflective-Reciprocal Peer Teaching Strategies enhanced pre-service science teachers' achievement and science process skills in integrated science when employed by the teachers of the subject. The two strategies should, therefore, be used for teaching Integrated Science at the College of Education level and Basic Science at basic education level.

Key words: Reflective-reciprocal Teaching strategy, Reflective-reciprocal peer tutoring strategy, Pre-service teachers, Science process skills, Achievement in Integrated science

INTRODUCTION

Integrated Science study started in Nigerian Colleges of Education in 1990/1991 session as Integrated Science. The curriculum provides for single and double major courses for the pre-service teachers. The single major programme enables the pre-service teacher to offer Integrated Science courses in addition to other single subjects. It is a 40 credit course load in Integrated Science with the remaining load for any other subject whereas the double major programme requires 72-credit course load for the pre-service teachers which is spread over duration of three years. But with effect from 2009/2010 session the double major programme has been scrapped, leaving only the single major programme.

Today, Integrated Science is offered in all colleges of education in Nigeria. The programme has helped in producing manpower for the teaching of basic science at the primary and junior secondary school levels of education. However, research reports show that the programme has not been quite successful (Olawaju, 1996). Some reasons were adduced for this, such as absence of science laboratories in preparing pre – science teachers in Nigeria Colleges of Education (Omoifo, 2010), fear and dislike of the physics aspect of Integrated science as highly mathematical and abstract in nature (Owolabi, 2008), lack of adequate supply of expert teachers of Integrated Science at college level, lack of adequate facilities for teaching Integrated Science using activities oriented method and ineffective methods used by the teacher of Integrated Science.

The Federal Government of Nigeria in its quest for scientific inquiry formulated goals in the national policy on education (FME, 2004) which reflect, amongst others, the acquisition of appropriate skills and the development of mental, physical and social abilities and competencies as requirement for the individual to live in and contribute to the development of the society. Educational activities, therefore, are expected to be centered on the learner for maximum self-development and self -fulfillment. In view of these, the junior school is made both pre- vocational and academic. The science teacher at this level is expected to teach science in order to enable the students acquire further knowledge about nature and acquire necessary skills to address life challenges.

The quest for the literacy of future generations led the Federal Government of Nigeria to come up with the National Commission for Colleges of Education (NCCE). This body is saddled with the responsibility of producing teachers with Nigeria Certificate in Education (NCE) to teach in primary and junior secondary schools. This programme with the sole aim of producing teachers to teach these levels of education effectively are mostly confronted with a lot of problems which account for the poor performance as shown in Table 1 and Figure 1 containing the final-year results of Integrated science students from Osun State College of Education, Ila, Federal College of Education, Abeokuta, Emmanuel Alayande College of Education, Oyo and Federal College of Education (Special), Oyo between 2005 and 2008. For the three sessions indicated in the table, a total of 1879 students in the final year took the final examinations, 694 passed the examination and 1185 failed. This implies that only 37% graduated while 63% did not graduate. This is not good enough when one considers the importance of the subject to the scientific literacy and technological development of the country.

TABLE 1 HERE FIGURE 1 HERE

Researchers have identified some probable causes of poor performance in the subject. These range from student factors like their poor attitudes to science, (Showers and Shrigley, 1995), lack of interest in science (Adepiton, 2003), lack of role models in the subject (Ivowi and Oludotun, 2001), poor mathematical background (Ogunleye, 2001). Government factors in the area of policy making,

infrastructural provision and teacher welfare (Ogunleye, 2001), teacher factors such as teaching methods employed (Adepitan, 2003; Kalijah, 2000) and unhealthy teacher-student relationship (Aysan, 1996).

There seems to be a general consensus of opinion among science educators concerning the vital role played by teaching methods or instructional strategies adopted by the teacher as these and other variables affect students' achievement and attitude to science (Akinsola, 1999; Gbolagade, 2009). He emphasized the importance of appropriate teaching method in the development of skills required for making science content relevant to the growth and development of both the individual and the society. He called for the adequate training of teachers, which should include the introduction of appropriate methods of teaching the subject-matter. Iroegbu (1998) observed that learners tend to derive maximum benefits in learning cognitive skills when the teaching strategy adopted involves the use of a mixture of different methods, while at the same time, creating opportunity for the learners to practice skills as meaningful whole. Learners must, therefore, be exposed to situations, which demand the knowledge and skills they are required to acquire and use.

Pre-service teachers' science process skills are aspects to be given considerable attention during their training period. This is necessary as they are being trained to teach others later. Integrating the science process skills into the teaching requires no drastic changes in teaching style but merely involves making the processes of science to be more explicit in lessons, investigation and activities already in use in science curriculum (Wetzel, 2008).

In 2009, the Oyo State Universal Basic Education Board (SUBEB) undertook monitoring and assessment of all the teachers in the primary school in the state and reported that the primary school teachers are performing poorly in all school subjects and even worse in the sciences (OYO SUBEB News, 2009; Akinsola, 2010). The report shows that the primary school teachers are not doing well academically both in pedagogy and in knowledge of the subject- matter. For the situation to be rescued there should be a reformation at the NCE level of education. Indeed, the pre - service teacher training programme in science should be properly looked into. They should be exposed to various teaching strategies that can arouse and sustain student interest, build up self efficiency and positively change the attitude of students to Basic Science. Many instructional strategies have been developed and found effective in teaching science. Examples are the collaborative group strategies for pre-service teachers by Gbolagade and Adedigba (2002), problem solving and concept mapping by Orji (1998) reform-based instruction by Barak and Shakhman (2008), meta-cognition strategy by Eldar (2008), self-regulation strategy by Arsal (2010) and Predict-Observe-explain strategies by Babajide (2010) to mention but a few.

In spite of all these efforts towards improved teaching strategies, the performance of students is still very low since all these laudable methods do not translate into use by classroom teachers some of who are not ready to change their classroom practices acquired during training. Also, most of these novel strategies are not recommended in the curriculum. So, the researcher is of the opinion that if these improved teaching strategies are emphasized and used in training the pre-service teachers, they would be familiar with these teaching strategies in the course of their training and find it more convenient and easy to use when they are in the field practising as teachers.

The National Commission for Colleges of Education (NCCE) recommended various teaching methods that can be used to teach Integrated Science course which includes demonstration, discussion, project, field trip, group discussion and lecture methods. Of all these, lecture method is the most popular, commonest and mostly abused in Nigerian classrooms (Duyilemi, 2005). It is mostly used in tertiary institutions. According to Oludipe (2003), persistent and remarkable expansion in student enrolment at all levels of education as well as shortage of classroom

accommodation and other necessary facilities may be responsible for the popularity of lecture method in Nigerian science classes. Again Lecture method is more effective in large classes.

Ogunsola- Bamidele (1996) has remarked earlier that lecture method is the most abused of all teaching methods and the least effective in many respects. This implies that the aims and objectives of Basic Science cannot be attained with lecture method; hence, there is the need for more involving methods of instruction. That is if Basic Science should be taught to achieve its stated objectives, an activity and student oriented approach should be used in line with the role of teacher which has gradually shifted from traditional disseminator to that of mentoring or tutoring. Here, the teacher assists students with sources of information and provides them with guidance. The teacher provides structural, supportive and professional role to the students in analysis, interpretation and reporting of findings (Sampson and Yeoman, 2010). Every educator has ethics and moral obligation to assist all students to realize their full potentials (Orlich, Harder, Callahn, Trivisan, Brown, 2010).

Students need to be given opportunity to be actively involved in the learning process (Duyilemi, 2005). Teaching is not simply standing in front of a class talking, the best teachers contemplate the manner in which they will present a topic and have a wide variety of instruction models at their disposal (Orlich et al, 2010). It is, therefore, imperative to create room for further search for instructional models that could appeal and arouse learners' interest and at the same time help to achieve the objectives of science education.

To achieve desired educational goals, teachers need to reflect on their teaching goals and how these interface with the demographics and abilities of their students. This process will, according to Clarke (2006), allow the teacher to clarify their knowledge base, the content, and their students' learning styles and crystallized the pedagogy to be implemented. In choosing instructional strategies, teachers need to consider the challenges that the students may encounter and strategies to assist the students in overcoming them. Teachers need to evaluate the lesson goals and the action of both themselves and their students as well as define the point at which difficulties emerged. A way of doing this is through constructivism which is learning in an active situation through which new knowledge is acquired by building on prior knowledge and metacognition which involves monitoring students' thinking and behaviors as they regulate what they do and think while having an experience in teaching (Hart, Dixon, Drummond, McIntyre, 2004).

Reflective Teaching is grounded in constructivism and metacognition where students and teachers are exposed to teaching and learning experience under the scrutiny of their peers and mentor or college supervisor who critiques their ideas (Clarke, 2006). Reflection, according to Clarke (2006), refers to thinking about the actual teaching which involves the thought teachers have before, during and after a lesson. This teaching strategy has not been given adequate attention in classrooms, especially in science related subjects but perhaps, could be used to achieve the objectives of basic science curriculum. At the pre-service level, it will be useful to train teachers who would adopt them when they will be practicing later in their career.

Reflective teaching is in three phases which are; the planning, teaching and debriefing phase. During the planning stage the teacher must use strategy(ies) like cooperative learning techniques, hands-on activities etc (Clarke, 2007). Based on these the researcher will use two cooperative teaching strategies with reflective teaching.

Reciprocal Teaching (RT) is a student-centered instructional strategy in which students and teachers switch roles in a lesson. It is a cooperative learning instructional method in which natural dialogues model reveal learners' thinking processes about a shared learning experience (Foster and Rotoloni, 2005). Teachers foster reciprocal teaching through their belief that collaborative construction of meaning between themselves and students lead to a higher quality of learning

(Allan, 2003; Akinsola, 2006). Students take ownership of their role in reciprocal teaching as they feel comfortable expressing their ideas and opinions in open dialogue. They take turns articulating with each learning strategy employed. The learning community is able to reinforce understanding and to see, hear and correct misconceptions that otherwise might not have been apparent. All members of the community have shared responsibility for leading and taking part in dialogue during learning experience (Hashed and Connor, 2003).

Furthermore, Reciprocal Teaching increases students' confidence and success in their understanding and use of strategies and in their enjoyment of literature. However, there is not enough literature on the use of RT in Science Education. According to Garderen (2004), a modified version of reciprocal teaching can benefit students who struggle to comprehend mathematical word problems. The four major component of this modified approach are clarifying, questioning, summarizing and planning. The PT could be of help in teaching Dynamics which is a physical aspect of Integrated Science and being mathematics oriented course. Reciprocal teaching is an instructional strategy based on modeling and guided practical in which the instructor first models a set of reading comprehension strategies and then gradually cedes responsibility for these strategies to the students (Brown and Palincsar, 1989;Palincsar, 1986;Palincsar and Brown, 1984).

Reciprocal Teaching consists of three main components: (a) the teaching and learning of specific concept and the strategies (b) the dialogue between an instructor and students where the instructor models why, when, and where to use the strategies and (c) the appropriating of the role of the instructor by the students, i.e. students begin to model the strategy for other students. Thus, the goals of RT are for students to learn the strategies, learn how and when to use the strategies and become self-regulated in the use of these strategies.

Reciprocal Peer Tutoring (RPT) is also an intervention in which one student provides instruction or academic assistance to another student. RPT is a form of cooperative learning, which has been found to be an effective technique for increasing students' academic achievement (Sharman, 1991; Slavin, 1991). Conceptually, Peer Tutoring is similar to many activities ranging from the informal encounters of play to the most complex activities of cooperation in which people help one another and learn by doing so. This process transforms learning from a private to a social activity by making learners to be responsible for their learning and that of others. Researchers have shown that both tutors and tutees gain immensely from participating in reciprocal peer tutoring (Slavin, 1996; Forman, 1994; Griffin and Griffin, 1997). In this process, students function reciprocally as both tutors and tutees. This dual role is beneficial because it enables students to gain from both the preparation and instruction in which tutors are engaged and from the instructions that tutees received (Griffin and Griffin, 1997). Successful peer-tutoring interventions have been carried out in school settings and have typically provided supplementary practice for fundamental skills such as reading, spelling, or mathematics (Mayfield and Vollmer, 2007). In addition, these interventions often involve extensive training (4 to 8 hours) prior to implementation, the use of structured formats and predesigned materials to guide instruction and precise methods of delivering feedback (Fuchs and Fuchs, 2001; Fuchs et al, 2001; Saenz, Fuchs, and Fuchs, 2005).

The mode of entry of students into the NCE programme is an index of students' previous knowledge or entry behavior. The Joint Admission and Matriculation Board (JAMB) was established by the Federal Government of Nigeria through Act 2 of 1978 to regularize the intake of students into universities and later polytechnics, monothechnics and colleges of education to solve the problem of multiple admission given to some candidates at the expense of others, (JAMB,1998). The mode of entry into NCE programme is in two forms: the direct entry handled by JAMB and preliminary studies handled by the colleges of education themselves. Daniels and Schouten in Adeyemi (2009) is of the opinion that a prediction of a future examination result could be made

with reasonable success on the basis of the result of an earlier examination and that grade may serve as predictive measure and as a criteria measure.

As an evidence of all the above assertions, the researcher investigates the effect of the reflective teaching model vis-à-vis reciprocal teaching and reciprocal peer tutoring on pre-service teachers' achievement and science process skills in pre-service Integrated Science. The researcher also looks into the moderating effects of mode of entry on their achievement and science process skills in pre-service Integrated Science.

Statement of the Problem

This study determines differential effectiveness of reflective- reciprocal teaching and reflective-reciprocal peer tutoring on pre-service teachers' achievement and science process skills in integrated science. The study further investigates the moderating effects of mode of entry of students into the college on the two dependent measures.

Hypotheses

The following null hypotheses were tested in the course of this study at 0.5 level of significance.

H₀₁: There is no significant main effect of treatment on pre-service teachers' achievement in Integrated Science

H₀₂:

There is no significant main effect of treatment on pre-service teachers' science process skills in Integrated Science

H₀₃: There is

no significant main effect of mode of entry on pre-service teachers' achievement in Integrated Science.

H₀₄: There is no

significant main effect of mode of entry on pre-service teachers' science process skills in Integrated Science

METHODOLOGY

The pretest- posttest, control group, quasi-experimental research design was adopted for this research. The participants for this study was taken from N.C.E II Pre-service teachers studying Integrated Science as teaching subject in the government owned eleven (11) colleges of education (four owned by the Federal government while the remaining seven by the State government) in South West Nigeria. From these Colleges Six (three federal and three state) was purposely selected based on their relative distance from one another. The colleges were randomly assigned to treatment and the control group. Two colleges were exposed to Reflective-Reciprocal teaching another two to Reflective- Reciprocal Peer Tutoring and the remaining two to the Conventional Teaching. From the selected colleges, intact classes of N.C.E II Integrated Science were used for the study.

Instrumentation

Six instruments used in the study were:

- | | |
|--|------------|
| Operational Guide for Reflective-Reciprocal Teaching Strategy (OGRRTS) | 1. |
| Operational Guide for Reflective-Reciprocal Peer Tutoring Strategy (OGRRPTS) | 2. |
| Operational Guide for Modified Conventional Teaching Strategy (OGMCTS) | 3. |
| Pre-service Teachers' Numerical Ability Test (PTNAT) | 4. Pre- |
| service Teachers' Achievement Test in Basic Science (PTATBS) | 5. Pre- |
| Process Skills Rating Scale (SPSRS) | 6. Science |

Operational Guide for Reflective-Reciprocal Teaching Model (OGRRTM)

This operational guide was used for teaching experimental group 1. It is an instructional guide based on the philosophy of cooperative work among learners and reflection on the part of the

trained lecturer. This operating guide is made up of four RT strategies of 'Predicting' 'Questioning' 'Clarifying' and 'Summarising'.

The research assistant models the four RT strategies, and then provides examples of meaningful dialogue in which text ideas were elaborately connected to previous knowledge and applied in new ways. Next, the trained lecturer provides guided practice for their students; gives them feedback on their use of RT strategies and allows them to take ownership of the strategy. The inter-rater reliability was then estimated using Scott's π . The inter rater reliability index obtained was 0.75.

Operational Guide for Reflective-Reciprocal Peer Tutoring Strategies (OGRRPTS)

This operational guide consists of five lessons that were used for treatment group II. The lesson plan was based on the steps listed by Utley and Mortweet (1997) as well as Fuchs and Fuchs, (2001). The main features of the guide are; general information, procedure, general objective, tutor training, peer tutoring, peers shifting of roles and the content of the subject-matters.. The inter-rater reliability was then estimated using Scott's π . The interrater reliability index obtained was 0.72.

3.5.3 Operational Guide for Modified Conventional Teaching Strategy (OGMCTS)

The instructional guide consists of six lessons that were used to teach pre-service teacher in the control group. The lessons were based on normal ways of writing lesson note. The main feature of the guide is: general information, the procedure, the teacher, general objectives, content for each lesson, summary and conclusion. The recommendations given were used to reconstruct some of the guide. The inter-rater reliability was then estimated using Scott's π . The inter rater reliability index obtained was 0.77.

Pre-service Teachers Numerical Ability Test (PTNAT)

This instrument was administered to the pre-service teachers before exposing them to treatment. The instrument developed by the researcher consists of two sections. The section A seeks for demographic information of the respondents such as name, college, sex and mode of entry while section B consists of 30 items which the pre-service teachers will solve on the space provided on the question paper to test their numerical ability level. To validate PTNAT, the instrument was given to two experts in Science Education. Their advice was incorporated into the items. The modified test items was administered to thirty five pre-service teachers that will not be involved in the main study to determine the reliability and internal consistency of the scores using Split-half method. The reliability index obtained was 0.79.

Pre-service Teachers' Achievement Test in Integrated Science (PTATIS)

This instrument tests the Pre-service teachers' intellectual achievement in speed and acceleration, linear momentum work, energy and power. The test contains fifty multiple-choice objective test items. It has two sections with Section A containing demographic information such as name, college, sex and mode of entry while section B containing the test items . The alternatives for the questions range from A to D. The items with moderate difficulty indices of 0.4 to 0.6 were retained while ensuring that such items had positive correlation with the entire test. The responses were used to determine the reliability using Kuder-Richardson formular 20 (KR-20). The KR-20 value of 0.85 was obtained.

3.5.6 Pre-service Teachers Science Process Skills Rating Scale (PTSPSRS)

This is made up of thirty two items on a 5-point rating scale to measure pre-service teachers' science process skills. The thirty two items were distributed among the six basic science process skills which are observing, classifying, measuring, communicating, inferring and predicting. The rating scales used are: Very Good=5, Good=4, Very Fair=3, Fair=2 and Poor=1. The inter-rater reliability was then estimated using Scott's π . The inter-rater reliability index obtained was 0.82.

Research Procedure

The following time schedule was used for the study. 1st -3rd weeks: Training of Research Assistant and discussion with lecturers in control group 4th week: Administration of Pretest and numerical ability test. 5th -9th weeks: Application of treatment on experimental and control group 10th week: Administration of Posttest and science process skill rating scale. (1) Training of Lecturers (3 weeks). (2) The researcher personally visit the participating lecturers who are the lecturers handling the course in their respective colleges and train them on how to implement the steps involved in the guides designed. Two lecturers were trained for each experimental group 1, experimental group II. The training covers one week each for each of the two groups. The researcher also visit the colleges used as control. (3) The fourth week was used for pretest administration for all pre-service teachers participating in the study using the achievement test and numerical ability test. (4) The fifth to tenth week was used for the implementation of the treatment (including pre-service teachers 'science process skills rating scale) for each of the two experimental and control groups. The pre-service teachers were rated during the first and the last activities class using the Pre-service Teachers' Science Process Skills rating scale with the activities recorded using video recorder.

Method of Data Analysis

Data collected were analyzed using Analysis of Covariance (ANCOVA). The Multiple Classification Analysis (MCA) aspect of ANCOVA was used to determine the magnitude of the performance of the various groups. Where there were significant main effects, the Scheffé Post-hoc Analysis was used to determine the sources of such significant differences. For significant interaction effects, graphical illustrations were used to explain such effects.

RESULTS

H₀₁: There is no significant main effect of treatment on pre-service teachers' achievement in Integrated Science

TABLE 2 HERE

Table 2 shows that there is significant effect of treatment on pre-service teachers achievement in integrated science ($F_{(2, 294)} = 56.149$; $p < .05$). This means that there is significant difference in the posttest achievement scores of those in the Reflective- Reciprocal Teaching, Reflective-Reciprocal Peer Tutoring and those in the control group. The null hypothesis H_{01} is, therefore, rejected.

In order to trace the actual sources of the significant effect of treatment on achievement, Table 3 presents the summary of Scheffé post hoc tests.

Table 3 here

Table 3. Shows that the Reflective-Reciprocal Teaching ($\bar{x} = 21.02$) significantly differs from the control group ($\bar{x} = 18.89$). Also, the Reflective-Reciprocal Peer Tutoring group ($\bar{x} = 24.84$) differs significantly from the control group. These significantly pair wise differences were therefore, responsible for the significant effect of treatment on achievement in Integrated. Science

H₀₂: There is no significant main effect of treatment on pre-service teachers' science process skills in Integrated Science

Table 4 HERE

Table 4 shows that there is significant effect of treatment on pre-service teachers science process skills in Integrated Science ($F_{(2, 294)} = 33.525$, $p < .05$). This implies that the difference in the science process skills of pre-service teachers exposed to Reflective-Reciprocal Teaching, Reflective-Reciprocal Peer Tutoring and control are significant. Hypothesis H_{02} is hereby rejected.

Table 5 Here

Table 5 shows that the significant effect of treatment on the pre-service teachers science process skills is due to the significant pair wise difference between RRT ($\bar{x}=57.50$) and RRPT ($\bar{x}=67.04$) as well as between RRT ($\bar{x}=57.50$) and the control group ($\bar{x}=47.04$).

Ho3: There is no significant main effect of mode of entry on pre-service teachers' achievement in Integrated Science.

Table 2 shows that mode of entry has no significant effect on the pre-service teachers achievement in Integrated. Science ($F_{(1, 294)} = .115$; $p > .05$). Based on this, hypothesis 3 is not rejected.

Ho4: There is no significant main effect of mode of entry on pre-service teachers' science process skills in Integrated Science

Table 2 shows that there is no significant effect of mode of entry on pre-service teachers' science process skills in integrated science ($F_{(1, 294)} = 1.030$; $p > .05$). Hypothesis 4 is therefore, not rejected.

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The major finding of this study is that there is a significant difference in the achievement of pre-service teachers exposed to Reflective-Reciprocal Peer Tutoring, Reflective-Reciprocal Teaching and the Modified Conventional Teaching strategies. The Reflective-Reciprocal Peer Tutoring was the most effective strategy followed by the Reflective-Reciprocal Teaching with the Modified Conventional strategy been the least effective. The superiority of Reflective-Reciprocal Peer Tutoring may be due to the fact that it had a structured format where pre-service teachers taught, monitored, and evaluated one another. That is, pre-service teachers were part of the teaching-learning process and were able to prepare instructional materials, plan the lesson, deliver the lesson, receive feedback from peers and reflect after the lesson to identify where problems arose with probable solutions provided against other classes. They functioned both as tutor and as tutee while the teacher acted as a facilitator.

Also the pre-service teachers monitored their academic progress in a group context, setting team goal and managing their own group reward. These assist the pre-service teachers to improve their perceptions of their own academic competence and self-control. It also made the pre-service teachers to be responsible for the actions in the class, monitoring their academic progress rather than being passive learners. The pre-service teachers were at the center of the teaching and learning process. The bulk of the responsibility lied on them with the classroom teacher only monitoring and providing help when the "teacher" had trouble answering students' questions. The pre-service teachers played the major and important roles in the classroom setting. These roles developed their self-confidence and made them to possess sense of self-direction and self-control in teaching. It also empowered them to take responsibility for their own action and that of their group.

Pre-service teachers' better performance in Reflective-Reciprocal Peer Tutoring may also be due to the fact that they worked cooperatively with their peers thereby providing the social context for the pre-service teachers to actively learn and make deeper connections among facts, concepts and ideas. This developed their social and communication skills, increased cooperation and tolerance of one another as pre-service teachers were from diverse background working together to achieve group goal and aspiration. This made learning to be more permanent The improvement in achievement with the use of Reflective-Reciprocal Peer Tutoring over the two other strategies may also be due to the fact that it utilized group reward system and interdependence that maximized learning and motivation. The pre-service teachers were active learners in the classroom. They took active part in the planning and delivering of a lesson thereby acquitting them with the role of a teacher. This findings is in agreement with the earlier research results obtained by Fantuzzo, King and Heller (1992), Slavin (1996) Griffin and Giffin (1997), Fuchs and Fuchs (2003) and Mayfield and Vollmer (2007).

The Reflective-Reciprocal Teaching was more effective than the Modified Conventional Strategy. This may be as a result of its shift from the instructor-centered to student-centered style where there was a construction of meaning between the Lecturer and the pre-service teachers which consequently led to high quality learning. The Pre-service teacher swapped roles with the Lecturer thereby increasing their confidence and level of understanding. This strategy encouraged the pre-service teachers to feel comfortable expressing their ideas and opinion in open dialogue. This dialogue included discussions, questions and answers, with feedback after which both the lecturer and the pre-service teachers reflected on what happened in the classroom. They identified common problems, thought about possible solutions and attempted an action plan to use against the forthcoming class. Also, in Reflective-Reciprocal Teaching the pre-service teachers thought before, during and after the lessons and this made them to consult different texts before the lesson and this in turn widened their horizon on the topic. This also helped the pre-service teachers to forge connections between theory and practice. The improvement on pre-service teachers performance in the strategy over the Modified Conventional strategy may also be as a result of pre-service teachers checking their understanding of materials they encountered by generating questions, clarifying concepts, summarizing important information from text and ruminating over all these after the class. This gave the pre-service teachers opportunity to monitor their learning and thinking processes. The Reflective-Reciprocal Teaching required the pre-service teachers to interact and participate actively in the class. This fostered healthy relationships and helped to create an ideal learning and social environment. The superiority of this strategy over the conventional strategy may also be as a result of the topic used being mostly in text with minimal mathematical operations as Reflective-Reciprocal Teaching strategy was most effective with text. This result is in agreement with the findings obtained by Lavariee (2000), Rosenshine (2003), Oczkus (2003), Hashey and Connors (2003) , Foster and Rotoloni (2005), Peter, David, Cheri, William and Carl (2006) and Clarke (2007) who all found Reflective-Reciprocal Teaching as effective in the teaching of science.

The result obtained showed that there was a significant main effect of treatment on pre-service teachers' science process skills. The Reflective-Reciprocal Teaching was more effective than the Reflective-Reciprocal Peer Tutoring and the Modified Conventional teaching strategy. The superiority of the Reflective-Reciprocal Teaching at improving science process skills may be as a result of the nature of the strategy which involved a little input by the lecturer since both the lecturer and the pre-service teacher shifted role during the lessons. The lecturer in this group brought their experience and expertise to bear. Hence, the science process skills acquired by the pre-service teachers in this group were higher than those acquired by pre-service teachers in the two other groups. This finding is in agreement with the results obtained by Harlen (2000) as well as Marzano, Pickering and Pollock (2001) that teachers' role have positive influence on the acquisition of science process skills.

The Reflective-Reciprocal Peer Tutoring was more effective than the Modified Conventional Teaching Strategy probably because pre-service teacher in this group were in full control of the activities involved in the practical class. Pre-service teachers in this group therefore acquired some skills and still retained those skills. This accounted for their higher adjusted posttest science process skills mean score and hence, the effectiveness of the Reflective-Reciprocal Peer Tutoring strategy over the Modified Conventional Teaching Strategy. This finding is in line with the finding of Driscoll, (2000) and Ong and Kenneth, (2005) who found that learners readiness, their interaction with others and active participation and involvement were major factor in development of science process skills.

Based on the results obtained and discussed in this study, the following recommendations are hereby made:

1. The use of Reflective-Reciprocal Peer Tutoring Strategy and Reflective-Reciprocal Teaching are recommended to lecturers for the teaching of Integrated Science in the colleges of education for better achievement.
2. The pre-service teachers should be encouraged by the lecturers to be familiar with both strategies so that it will be convenient and easy for them to use when practicing as a teacher.
3. The use of Reflective-Reciprocal Teaching is recommended in practical class for better acquisition of science process skills in Integrated Science.
4. The pre-service teachers should be made to use both strategies by the lecturers and supervisors when on teaching practice to improve the achievement of their students.
5. The lecturer and pre-service teachers should be encouraged by their lectures to be a reflective teacher as this would be a form of professional development.
6. Government should organize a form of in-service and re-training programme for teachers in the effective use of the Reflective-Reciprocal Peer Tutoring and Reflective-Reciprocal Teaching Strategies through organization of seminars, workshop, and conferences for science teachers.

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Table 1: Integrated Science Final N.C.E. Result for Selected Colleges of Education

Year	College	No examined	No Pass	% Pass	No failed	% failed
2005-2006	School 1	190	42	22.1	148	77.9
	School 2	234	117	50.0	117	50.0
	School 3	206	73	35.4	133	64.6
	School 4	46	18	39.1	28	60.9
2006-2007	School 1	152	34	22.4	118	77.6
	School 2	142	67	47.2	75	52.8
	School 3	229	88	38.4	141	61.6
	School4	56	20	34.7	36	64.3
2007-2008	School 1	174	48	27.6	126	72.4
	School 2	136	67	49.3	69	50.7
	School 3	266	101	37.9	165	62.1
	School 4	48	19	39.6	29	60.4
Total		1879	694	36.9	1185	63.1

Fig. 1: Integrated Science Final NCE Result from the selected Colleges of Education

Sources: Academic Records Section of Osun State College of Education Ila.

Academic Records Section of Federal College of Education, Abeokuta

Academic Records Section of Emmanuel Alayande College of Education, Oyo.

Academic Records Section of Federal College of Education (Special), Oyo.

Key

School 1: Osun State College of Education Ila, Osun State

School 2: Federal College of Education, Abeokuta, Ogun State

School 3: Emmanuel Alayande College of Education, Oyo, Oyo State

School 4: Federal College of Education (Special), Oyo, Oyo State.

Table 2: Summary of Ancova of Post Test Achievement by Treatment, Numerical Ability and Mode of Entry

Source of varicose		Sum of square	df	Mean square	F	Sig
Covariates	PRE-ACHVT	3939.219	1	3939.219	262.297	.000
Main effects	(combined)	1751.708	5	350.342	23.328	.000
	TREATMENT	1686.517	2	843.258	56.149	.000
	MODE	1.735	1	1.735	.115	.123
	NUMUMERICAL ABILIT	63.456	2	31.728	2.113	.734
2-way interactions	(Combined)	75.086	8	9.386	.625	.757
	TREATMENT× MODE	5.232	2	2.616	.174	.840
	TREATMENT×					
	NUMERICAL ABILITY	41.233	4	10.308	.686	.602
	MODE× NUMERICAL					
ABILITY		37.853	2	18.296	1.260	.285
3-Way Interaction	TREATMENT×MODE×	11.566	4	2.892	.193	.942
	NUMERICAL ABILITY	5777.579	18	320.977	21.373	.000
Model		4145.011	276	15.018		
Residual		9922.590	294	33.750		
Total						

* Significant at p<.05

Table 3: Scheffé Post hoc Tests of Achievement by Treatment

Treatment	N	\bar{x}	Treatment		
			1. Reflective-Reciprocal Teaching.	2. Reflective-Reciprocal. Tutoring	3 control Peer.
Reflective- Reciprocal Teaching	121	21.02			*
Reflective-Reciprocal Peer Tutoring	109	24.84			*
Control	65	18.89	*	*	

* Pairs of groups significantly different at p<.05

Table 4: ANCOVA of Posttest Science Process Skill Score of Pre-service Teachers by Treatment, Numerical Ability and Mode of Entry

Source of varicose		Sum of square	df	Mean square	F	Sig
Covariates	PRE-SKIL	41773.420	1	41773.420	2058.886	.000
Main effects	(combined)	1416.579	5	283.316	13.964	.000
	TREATMENT	1360.388	2	680.194	33.525	.000*
	MODE	20.898	1	20.898	1.030	.311
	NUMUMERICAL ABILIT	35.294	2	17.647	.870	.420
2-way interactions	(Combined)	218.994	8	27.374	1.349	.219
	TREATMENT× MODE	71.418	2	35.709	1.760	.174
	TREATMENT×					
	NUMERICAL ABILITY	112.159	4	28.040	1.382	.240
	MODE × NUMERICAL ABILITY	20.366	2	10.183	.502	.606
3-Way Interaction	TREATMENT×MODE×					
	NUMERICAL ABILITY	120.664	4	30.166	1.487	.206
Model		43529.656	18	2418.314	119.191	.000
Residual		5599.856	276	20.289		
Total		49129.512	294	167.107		

*Significant of $p < .05$

Table 5: Scheffé Post hoc Tests of Science Process Skills by Treatment

Treatment	N	\bar{x}	Treatment		
			1.Reflective- Reciprocal Teaching	2.Reflective- Reciprocal Tutoring Peer	3 Control
1.Reflective- Reciprocal Teaching	121	57.50		*	*
2.Reflective- Reciprocal Peaching Teaching	109	49.28	*		
3.Control	65	47.04	*		

* Pair of groups significantly different at $p < .05$

FIGURE 1

