COMPARATIVE EFFECTIVENESS OF MATHEMATICS AND BIOLOGY TEACHERS' LESSON STUDY ON STUDENTS' ACADEMIC PERFORMANCE

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Abstract

Teachers collaboratively working to develop and execute classroom instructions until it has been fine-tuned to the greatest extent possible while also collecting data on how well the lessons performs is critical to improving students' performance. This study focused on the comparative effectiveness of mathematics and biology teachers' lesson study on students' academic performance. The research design used in the study is quasi-experimental design of the pretest and posttest control group. A sample of 102 senior secondary school students and 10 (5 mathematics and 5 biology) teachers were selected from two secondary schools in Ekiti State Nigeria. The two schools were purposively selected; the school selected must have more than four mathematics and four biology teachers. The intact classes of the selected schools were used in the study. Three research instruments were used for data collection namely; Mathematics Performance Test (MPT), Biology Performance Test (BPT) and Lesson Study Inventory (LSI). Kudar-Richardson 20 (KR-20) was used to determine the reliability coefficient of the MPT and BPT after administering it to 20 students outside the study area. The analysis yielded a reliability coefficient of 0.741 and 0.796 for MPT and BPT respectively. The MPT and BPT were administered to the students as a pretest before the treatment and as a posttest after the treatment, while data was collected from the instruments. Mean, standard deviation and bar charts, t-test, Analysis of Covariance (ANCOVA) and Estimated Marginal Means (EMM) were used to analyze the data collected. The study revealed that teachers' lesson study significantly affect the students' mathematics performance ($F(2, 99) = 185.915$; $p<0.05$); teachers' lesson study significantly affect the students' biology performance ($F(2, 99) = 616.335$; $p<0.05$); there was a significant difference between the academic performance of students whose teachers engage in lesson study in mathematics and biology ($t = 12.562$; $df = 90$; $P < 0.05$) in favour of biology. It was recommended that mathematics and biology teachers should regularly engage in lesson study over a long period.

Keywords: Lesson study, professional development, Mathematics, Biology, performance

Introduction

The teachers are ultimately accountable for transforming policy into actions and principles based on practice through their interactions with the students. Teachers are essential to both the process of passing on knowledge and the quality of students' understanding of concepts of science and mathematics. There is no use in having a well-developed and comprehensive curriculum if it cannot be put into practice; the teachers are directly responsible for its implementation. The limit to the success of using a curriculum depends on the calibre of the teacher and what they do during classroom instructions.

The knowledge acquired during the teacher education programme cannot adequately take a teacher through an active teaching career if such a teacher desires to be effective in knowledge transmission. Individual growth within the context of one's professional function is considered part of the broader concept of "professional development". Teachers' professional progress or growth is consequential to increased experience and methodical evaluation of their own teaching. It is very essential to get both formal and informal experiences to advance one's career. Formal experiences include things like attending workshops, seminars and conferences, as well as more casual ones like reading academic journals and viewing movies about the field (Yuen, 2012; Ganser, 2000). People often think of teachers as reflective practitioners who join the field with a certain foundation of knowledge and then build on that foundation to learn and grow in their expertise. The goal of professional development is to assist educators in the creation of new educational techniques as well as in the growth of their competence (Dodds, 2001). Professional development for teachers may be broken down into two basic categories: initial preparation and continuing developmental growth. Colleges of education and universities provide full-time residential pre-service programs for intending teachers. Unqualified teachers may also have access to initial training via online education, 'out-of-school' programs during holidays or when they are released from schools for lengthy periods (McMahonand Hines,2008).

The practice of evaluating a teacher's content and pedagogical levels in a teaching/learning setting is known as lesson study. In many cases, teachers use this method by observing colleagues. To help teachers improve their lesson plans and their knowledge of student learning, this model of professional development has been developed and implemented. Other professional development programs for teachers cannot be compared to lesson study. Most teacher professional development is done in a way that encourages teachers to sit back and take notes, rather than actively participating in the learning process. In the end, lesson study is not about preparing and delivering a great lecture. Lesson study is a kind of teacher-led professional development in which educators review and revise their own methods for teaching and learning (Yoshida, 2005). Unlike other forms of teacher cooperation, lesson study provides a logical and seamless way to produce courses to help students learn more quickly and efficiently. Even in the classrooms itself, teachers collaborate with one other to

watch and assess how students are functioning. Teachers use their classrooms as a laboratory to continually enhance their teaching and learning methods.

A lesson study is an in-school teacher education technique that includes pre-collaborative work among teachers, lesson observations, and post-collaborative work (Lewis et al., 2012). Incorporating peer-to-peer professional learning is a powerful method. Teachers and other educators must work together to improve a specific lesson until it has been honed to the maximum extent feasible and then teach it to get strong data about how effectively the lesson performs. After the lesson has been presented, the teacher (who may or may not be a member of the lesson study group) will reflect on the lesson and the other members of the lesson study group will contribute information they obtained during the session. According to Lewis (2000), there are two options available for lesson study groups: the group may either use the field-tested lesson as it is or use what they've learnt in the process for another lesson.

There are four processes involved in Lesson Study in practice: reviewing curriculum and objectives, planning lessons, executing lesson study, and reflecting on observations. With the help of a team of teachers from the same subject area, these phases are accomplished (Lewis & Hurd, 2011).

Figure 1: Teachers' Lesson Study Cycle

The review of the curriculum and objectives to be achieved for the selected topic comes first. This is followed by planning how to execute the lesson; getting all the needed resources. In the third stage, the lesson is executed and during this period observations about the activities that are taking place in the classroom are recorded by the observing teachers. In the fourth stage, the teachers in the team reflect on the lesson stressing out the strength and the

weaknesses as noted by the observing teacher, this is done to improve on the next lesson. This process keeps going on in a cycleto always have a productive presentation of the lesson.

Popoola and Falebita (2016) noted that teacher lesson studies begin with a teacher's preparation for teaching a certain subject and suggestions for teaching are offered by other teachers; this always focuses on the availability of a lesson note, the declaration of lesson objectives, and the organization of information. Another thing to think about while doing a lesson study is how to deliver the contentlogically and sequentially. Inquiry into how well a lesson is set up, how well it is presented and how well students participate are all part of this evaluation. Other factors considered are the quality of the teaching aid, the topic's relevance to the teaching aid, how well students participate and how well the teacher manages time. The teacher's class management is examined in terms of class organization, class layout, and the teacher's ability to recognize and respond to class issues. As part of a teacher's lesson study, the effectiveness of a lesson's evaluation, summary, and follow-up assignment are all assessed. After looking at teachers'appearance (clothing, neatness), motivation to teach, em2otional stability and confidence, the lesson study of teachers also looked into the teacher's personality/professional views and values.

Lesson study provides several advantages, according to various researchers. Lewis, Perry, Foster, Hurd and Fisher (2011) discovered that teachers who participated in lesson study groups were able to "produce broad, sustainable progress" in their teaching approaches. Both inexperienced and experienced teachers benefited from lesson study. To plan a successful class and gather data on students' learning throughout the session, "all participants, regardless of their degree of skill," work together (Lewis et al., 2011). At the end of their research, they concluded that lesson study has the capacity to advance the education profession beyond conventional hierarchical conceptions of coaching and leadership toward a paradigm that both demands and encourages lifelong learning by all participants, from newbie teachers to seasoned leaders of professional learning. Re-teaching a lesson after reflecting on it has been shown in other research to improve teachers' attention to students' thoughts, challenges, and capabilities (Robinson &Leikin, 2011).

In order to better serve students and teachers alike, lesson study is an essential part of professional development (Yoshida, 2005). According to Yoshida (2005), lesson study has played a major influence in altering teaching and improving student learning. According to Lewis (2002), lesson study has had a significant role in fostering educational innovation. According to Matura (2011), it has also helped teachers build a better knowledge of the topic and students' thinking.Popoola and Falebita (2016) found teachers' lesson study to significantly improve students' academic performance in mathematics. According to Lewis (2002),lesson study of teachers improves students' success on achievement tests.According to Ylonen and Norwich (2012), the teaching-learning process improves greatly when teachers engage in lesson study while the performance of students in science also improves. During lesson study, teachers can collaborate to find solutions to learning-related issues, which suggest that student learning outcomes could be significantly enhanced.

Mathematics is important not just because of its contributions to the advancement of science and technology, but also because it is used by both educated and illiterate members of society in their day-to-day interactions. Secondary school students are obliged to take it because of its importance for academic advancement.A lot of students at Nigerian tertiary institutions arenot able to pursue their original choices of courses since they didn't get the requisite SSCE mathematics grade.In addition to being a necessary and compulsory school subject, mathematics is also related to a greater number of academic and career chances (Popoola, 2014).Popoola (2008) argues that different conceptions of Mathematics influence how society views Mathematics. She further stressed that mathematics is perceived by students as 2abstract with little area of application and relevance to an individual's life. Students perceived mathematics to be more difficult than any other science subject and between the sciences subjects, the more mathematics or calculations involved in the subject the more difficult they are perceived (Popoola, 2008).

Biology is a natural science field that focuses on the study of predominantly living things. It is a natural science subject that primarily investigates living things. Biology is also concerned with the structures, functions, development, origin, evolution, distribution, interrelationships, and adaptations of living creatures, among other aspects of their existence. For example, biochemistry may be combined with biology and chemical sciences, astrobiological sciences can be combined with biology and astronomy, and astronomy can be combined with other disciplines.At the secondary school level, biology is supposed to be taught in such a manner that it helps students investigate and understand living and non-living things (Ayeni, 2016). This is expected to enhance their academic performance in both internal and external examinations. According to Ayeni (2016), teachers of biology are required to use effective instructional practices in the classroom to enhance students' performance.

Educators of mathematics and biology need to look for and get involved in ways to equip themselves with shared experiences that will help them construct more systematic pictures of improvements in mathematics and biology education. It appears that severalmathematics and biology teachers do not plan their lessons and those who do tend to be teacher-centred rather than student-centred in their approach to finding effective teaching strategies, instructional materials, and teaching approaches that help their students grasp the concepts they are trying to teach.

Statement of the problem

The connection between students' performance and the teacher has been established by various researches. Researchers have been able to link the poor performance of students in Biology and mathematics back to their teachers. Many students' poor results on their Senior Secondary School Certificate Examinations have been blamed on ineffective classroom management techniques adopted by the teachers. This is a situation where students perform

poorly because of poor planning and instructional materials, avoidance of the teaching of certain topics that are perceived as difficult, and a poor attitude towards mathematics and science among teachers and students.

When it comes to student performance in senior school certificate examinations, little or no progress has been made over the years, particularly in mathematics and biology. Poor performance in Nigerian secondary school mathematics and biology appear not to have been addressed, despite the efforts of stakeholders to promote the teaching of mathematics and science in schools (e.g., seminars and workshops), as well as curricular innovations.It generally appears that most secondary school students see mathematics and science as a problematic or abstract concept. Educators not working together to develop an effective method of teaching mathematics might be blamed for this. Therefore, bringing teachers together to plan, execute, observe and review lessons is critical to gaining experience from one another as the teaching-learning process improves.

Purpose of the study

The main objective of the study is to compare the effectiveness of Mathematics and Biology Teachers' Lesson study on students' academic performance. Specifically, the study examined the;

1. Effect of mathematics teachers' lesson study on students' academic performance
2. Effect of Biology teachers' lesson study on students' academic performance
3. Difference between the academic performance of students whose teachers engage in 2lesson study mathematics and biology

Research Question

1. What is the difference in the performance of students in mathematics and biology when their teachers engage in lesson study?

Hypotheses

1. There is no significant effect of mathematics teachers' lesson study on students' academic performance
2. There is no significant effect of Biology teachers' lesson study on students' academic performance
3. There is no significant difference between the academic performance of students whose teachers engage in lesson study in mathematics and biology

Methods

The research design adopted for this study is a quasi-experimental design that employed a pre-test, post-test, control group design. The experimental group was exposed to Teacher Lesson Study while the control group was exposed to the conventional teaching method. The population consisted of Senior Secondary School Two (SSS II) students, and Mathematics and biology teachers from public secondary schools in Ekiti State. The sample for this study was102 Senior Secondary School Two (SSS II) students and 10(5 mathematics and 5 biology) teachers randomly selected from two Secondary Schools in Ekiti State.The two

schools were purposively selected; the school selected must have more than four mathematics and four biology teachers who can collaboratively engage in lesson study. The intact classes of the selected schools were used in the study.

Three research instruments were used for data collection. These include the Mathematics Performance Test (MPT), Biology Performance Test (BPT) and Lesson Study Inventory (LSI). The MPT and BPT consisted of two sections (A and B); section A sought the demographical information of the students while section B consisted of 30 multiple choice questions optioned A to D adopted from the WAEC past questions, based on the topics taught in the study. The LSI is the instrument used by the observing teachers to take the inventory of the activities carried out during the execution of the lesson study which is later used to discuss, plan, and prepare for subsequent lessons. WAEC examiners assisted in ensuring the face and content validity of the MPT and BPT. The MPT and BPT were administered to 20 students outside the study area, and the data gathered from their responses were analysed using Kudar-Richardson 20 (KR-20) to determine the reliability coefficient of the instruments. The analysis yielded a reliability coefficient of 0.741 and 0.796 for MPT and BPT respectively.

Procedure

At the pre-treatment stage, the MPT and BPT were administered to the students in both the experimental and the control groups as the pretest. The teachers in the lesson study group were trained on how to plan, prepare and observe the lesson using the LSI. They were also trained on how to discuss the outcome of the lesson with the aid of the LSI in order to improve the subsequent lessons. This lasted for a week. At the treatment stage, the experimental group was exposed to lesson study while the control group was exposed to the conventional teaching method; both groups were taught the same academic content for six weeks. After six weeks of administering the treatment, the MPT and BPT were administered to the experimental and the control group after rearranging the options of the questions as a posttest. The data (scores) gathered from the pretest and posttest were analysed using mean, standard deviation, ANCOVA, t-test and estimated marginal mean. The hypotheses were tested at a 0.05 level of significance.

Results

Research Question One*:* What is the difference in the performance of students in mathematics and biology when their teachers engage in lesson study?

Table 1:

Students' Performance Means Score Difference Between Mathematics And Biology Teachers' Lesson Study Groups

Teachers Lesson Study	N	Pretest	Posttest	Mean Gain	SD	Mean Difference
Mathematics	46	4.37	19.43	15.06	1.99	4.87
Biology	46	8.02	24.30	16.28	1.72	

Table 1 shows a performance score of 19.4348 and 24.3043 for students in mathematics and biology whose teachers engage in lesson study, while the standard deviations also show 1.9850 and 1.7239 respectively. The difference between the students' performance mean scores in mathematics and biology when their teachers engage in lesson study is 4.8695.

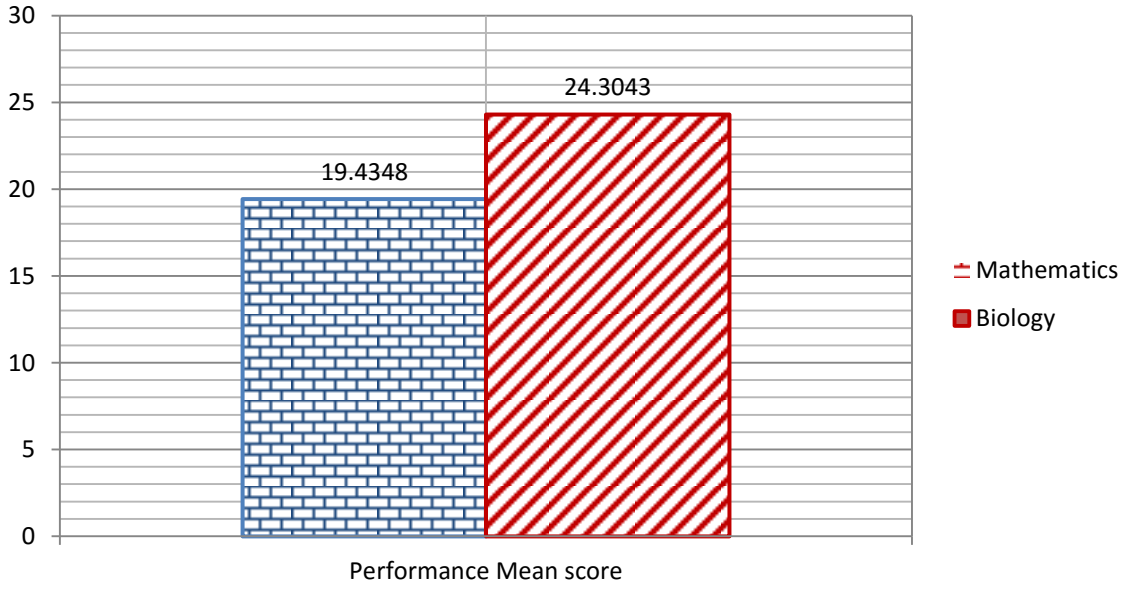

Figure 2: Students' Performance scores in Mathematics and Biology

The chart in Figure 2 showed the performance mean score of students in Mathematics and Biology when their teachers engage in lesson study. This further supports the results in Table 1.

Hypothesis one: There is no significant effect of mathematics teachers' lesson study on students' academic performance.

In determining teachers' lesson study effect on the mathematics performance of students, ANCOVA statistics was used to analyze the pretest and posttest scores of the students and the result is as presented in Table 2.

Table 2:
Analysis of Covariance (ANCOVA) of Mathematics Performance of Students exposed to Teacher's Lesson Study

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1129.105[a]	2	564.553	92.958	.000
Intercept	2906.078	1	2906.078	478.508	.000
PRE_MPT	.557	1	.557	.092	.763
GROUP	1129.100	1	1129.100	185.915	.000
Error	601.248	99	6.073		
Total	27080.000	102			

Corrected Total	1730.353	101

a. R Squared = .653 (Adjusted R Squared = .646)

Table 2 shows that the group were homogenous before the commencement of the experiment (F=0.092 and p=0.763). The table also indicates that teachers' lesson study significantlyaffects the students' mathematics performance (F(2, 99) = 185.915; p<0.05). Hence, hypothesis 1 is rejected. This implies that there is a significant effect of mathematics teachers' lesson study on students' academic performance.

Also, to determine the magnitude of the mean scores of students in the Mathematics Teacher Lesson Study(MTLS) and control groups, Estimated Marginal Mean (EMM) was used,Table 3 shows the result.

Table 3:

Estimated Marginal Mean of Students' Mathematics Performance

			95% Confidence Interval	
GROUP	Mean	Std. Error	Lower Bound	Upper Bound
Conventional	12.748[a]	.329	12.095	13.402
MTLS	19.437[a]	.363	18.716	20.158

a. Covariates appearing in the model are evaluated at the following values: PRE_MPT = 4.4118.

As presented in Table 3, the Estimated Marginal Mean (EMM) of students' mathematics performance in the MTLS and conventional group are 19.437 and 12.748 respectively; this is an indication that MTLS group has a higher EMM than the conventional group. This implies that mathematics teachers' lesson study contributes immensely to the difference in the academic performance of students between the BTLS and conventional groups in mathematics.

Hypothesis two: There is no significant effect of Biology teachers' lesson study on students' academic performance

To determine the effect of teachers' lesson study on the performance of students in biology, the ANCOVA statistics were used to analyze the pretest and posttest scores of the students and the result is as presented in Table 4.

Table 4:

Analysis of Covariance (ANCOVA) of Biology Performance of Students Exposed to Teacher's Lesson Study

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1611.189[a]	2	805.595	332.054	.000
Intercept	818.025	1	818.025	337.178	.000
PRE_BPT	1.770	1	1.770	.730	.395
GROUP	1495.287	1	1495.287	616.335	.000
Error	240.183	99	2.426		
Total	42332.000	102			
Corrected Total	1851.373	101			

a. R Squared = .870 (Adjusted R Squared = .868)

It is shown in Table 4 that the group were homogenous before the initiation of the treatment (F=0.730 and p=0.395). The table also indicates that teachers' lesson study significantly affects the students' biology performance (F(2, 99) = 616.335; p<0.05). Hence, hypothesis 2 is rejected. This implies that there is a significant effect of biology teachers' lesson study on students' academic performance Also, to determine the magnitude of the mean scores of students in the Biology Teacher Lesson Study (BTLS) and control groups, Estimated Marginal Mean (EMM) was used, Table 5presents the result.

Table 5: 2
Estimated Marginal Mean of Students' Performance In Biology

			95% Confidence Interval	
GROUP	Mean	Std. Error	Lower Bound	Upper Bound
Conventional	16.350[a]	.211	15.932	16.769
BTLS	24.269[a]	.233	23.806	24.732

a. Covariates appearing in the model are evaluated at the following values: PRE_BPT = 7.7157.

Table 5 shows the Estimated Marginal Mean (EMM) of students' performance in Biology in the BTLS and conventional groups are 24.269 and 16.350 respectively; it is an indication that BTLS group has a higher EEM than the conventional group. This implies that biology teachers' lesson study contributes immensely to the difference in academic performance of students between the BTLS and conventional group in Biology.

Hypothesis three: There is no significant difference between the academic performance students whose teachers engage in lesson study in mathematics and biology.

Table 6:
t-test Comparison of the Mathematics Interest Mean Scores of Male and Female Students

SUBJECT	N	Mean	SD	Df	t-value	p
Mathematics	46	19.4348	1.9850	90	12.562	.000
Biology	46	24.3043	1.7239			

According to table 6, students in the mathematics teachers' lesson study hada mathematics performance mean score of 19.4348 and a standard deviation of 1.9850 while the biology teachers' lesson study had a biology performance mean score of 24.3043 and a standard deviation of 1.7239. The table revealed a t-test significant result at 0.05 significant level: (t = 12.562; df = 90; P < 0.05). Hypothesis 3 is therefore rejected. This shows that there was a significant difference between the academic performance of students whose teachers engage in lesson study in mathematics and biology.

Discussion

The result from the study indicated that there is a significant effect of mathematics teachers' lesson study on students' academic performance. This is an indication that when teachers

collaboratively work together to engage in lesson study by planning the lessons together, where the concept that is not clear or difficult can be explained or solved together; lessons' delivery ca2n be observed to identify the strength and weaknesses of the teaching method, instructional materials used, classroom management among others to improve on the subsequent lessons, students' performance is enhanced. Teachers reflect on a lesson and re-teach to give adequate attention to students' needs. This agrees with the opinion of Robinson and Leikin (2012), that re-teaching a lesson after reflecting on it improves teachers' attention to students' thoughts, challenges, and capabilities. The finding is also in line with that of Lewis (2002) who revealed that there is a significant improvement to student performance on Mathematics achievement tests under the lesson study.

The study also found a significant effect of biology teachers' lesson study on students' academic performance. This is an indication that teachers' lesson study has the potency of 2improving the teaching and learning of sciences particularly biology and invariably improve the academic performance of students. This concurs with the findings of Matura (2011) and Ylonen and Norwich (2012) who all at different times found that the performance of students in science greatly improves when the teachers engage in lesson study.

The finding of the study revealed that there was a significant difference between the academic performance of students whose teachers engage in lesson study in mathematics and biology. The finding shows that the students had higher performance mean scores in biology than mathematics. This could be an indication that the students find biology more interesting than mathematics. This could also own to the abstract nature of mathematics. This agrees with the opinion of Popoola (2008) who revealed that students perceived mathematics to be more difficult than any other science subject and between the science subjects, the more mathematics or calculations involved in the subject the more difficult they are perceived.

Conclusion

Teachers' Lesson Study is effective in bringing improvement to every lesson, enhancing the effectiveness of the teacher and bringing about general professional development in the teacher. It was concluded in this study that mathematics teachers' lesson study improves the academic performance of students. Also, the biology teachers' lesson study greatly improves the performance of students in biology. It was also concluded that the biology teachers' lesson study is more effective in improving students' performance than the mathematic teachers' lesson study.

Recommendations

Based on the finding of this study, it is hereby recommended that the;

1. Mathematics and biology teachers should engage in lesson study for a long period; at least a period of one academic session.
2. Mathematics teachers should look into students' attitudes towards mathematics while involved in lesson study so that it can be improved.

3. Mathematics and science teachers should regularly attend seminars, workshops or training that focus on lesson study to be more skilful in the implementation of lesson study.
4. Education policymakers should make policies that give room for the adoption of lesson study by mathematics and science teachers. Government officials and school administrators should monitor the implementation of teacher lesson study in schools.

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