The Impact of Collaborative Educational Approach on Some Undergraduate Students of Statistics and Linear Algebra at Federal College of Education, Katsina in Katsina State of Nigeria

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Abstract
The study was on the impact of collaborative educational approach on statistics and linear algebra learning involving undergraduate students of Federal college of Education Katsina, Katsina State of Nigeria. The objective is to investigate whether the performance in statistics and linear algebra of those students taught using collaborative educational approach is better than those taught using traditional method. Collaborative educational approach is a teaching and learning educational method which involves grouping students to solve a problem. Collaboration is becoming increasingly important to colleges, universities and business enterprises and its benefits are numerous. The method was compared with the traditional method to see its impacts on the performance of students. Thirty students each were randomly selected for both the experimental and control groups. The control groups were taught using the traditional method while the experimental groups were taught using the collaborative educational approach. The Researcher Made Test (RMT) on statistics and linear algebra were used for data collection. Pre-test post-test was the experimental design and a t-test was used to compare the data. The pre-test assessment showed that there was no significant difference between their performances before applying the two instructional strategies i.e. $p>0.05$. However, there was a significant difference between the mean performances of the traditional method and the collaborative method i.e. $p<0.05$ after the application of the two instructional strategies. It was concluded that collaborative educational approach was a better method for teaching and learning statistics and linear algebra. Workshops and seminars were suggested to sensitize teachers and students on collaborative educational approach of teaching and learning for better performance.

Keywords: collaborative educational approach, performances, traditional learning method, undergraduate students.

1. Introduction

One of the importance of teaching and learning is for the learners to understand the concept been taught such that the objectives of that lesson are achieved. When this is not achieved, then there is a problem. This study came to mind when reading such articles like that of Lew, *et al.* (2016) in which they pointed out that the students did not comprehend the ideas the experienced professor cited as central to his lecture. In their research, they thought of two potential barriers to that problem;

- the students may have failed to encode the content of the lecture and were unable to comprehend those main points or the objectives intended by the professor as well as connecting these points to their own prior knowledge
- even if students understood the main ideas of the lecture, they may be unable to distinguish these important ideas from other superficial comments, and this may lead them to focusing on minutia rather than on the main points that the lecturer intended to make.

Therefore, to achieve the objective of any lesson, there is need to find a method that will be beneficial to both the teaching profession and the entire students especially at advanced level. Comparing the collaboration with the traditional lecture method was chosen because educators from K12 to the university classroom have long preferred collaborative approaches to teaching and assessing students. Recently, educators and policy makers have also identified the ability to collaborate as an important outcome in its own right rather than merely a means to an end. The Partnership for 21st Century Skills has also identified collaboration as one of several learning and innovation skills necessary for post-secondary education and workforce success (Lai, 2011).

2. Literature Review

2.1 Collaborative Learning

The concept of collaborative learning involves the grouping and pairing of learners for the purpose of achieving a learning goal. It refers to an instructional method in which learners at various performance levels work together in small groups toward a common goal. The learners are responsible for one another's learning as well as their own. Thus, the success of one learner helps other students to be successful (Gokhale, 1995) in (Laal and Ghodsi, 2012). Therefore, collaboration could be said to be a philosophy of interaction and personal lifestyle where individuals are responsible for their actions, including learning and respect the abilities and contributions of their peers Panitz (1999).

Also, Roschelle and Teasley (1995) in Lai (2011) opined that collaboration takes place within a joint problem space, which provides the structure needed to allow meaningful conversations about the problem. To construct a joint problem space, partners must have ways to introduce and accept knowledge, monitor exchanges for evidence of divergent meanings, and repair any divergences identified.

Collaboration is sometimes distinguished from cooperative learning since cooperative learning is accomplished through the division of labour, with each person responsible for some portion of the problem solving. Collaboration, on the other hand, involves participants working together on the same task, rather than in parallel on separate portions of the task. Therefore, it is a mutual engagement of participants in a coordinated effort to solve a problem together (Lai 2011).

Clare (2015) further stressed that collaborative learning provides students opportunities to engage with each other in thoughtful learning. The underlying premise of these techniques is that learning is enhanced by peer interaction. It is commonly illustrated when groups of students work together to search for understanding, meaning or solutions or to create an artefact or product of their learning. Furthermore, it redefines traditional student-teacher relationship in the classroom because activities can include collaborative writing, group projects, joint problem solving, debates, study teams, and other activities in which students team together to explore a significant question or create a meaningful project.

Therefore, collaborative learning is based on consensus or cooperation by group members rather than competition in which individuals tried to out smart other group members. Learning practitioners tried to apply this philosophy in the classroom, at committee meetings, with community groups, within their families and generally as a way of living with and dealing with other people (Panitz, T., 1996) in Laal and Ghodsi (2012). Therefore, children need to learn how to work together because team work is most supported in any work environment, and should be used as often as possible in the learning environment (Clare, 2015).

2.2 Theoretical Perspectives

Lin (2015) opined that the supporting theories are three: Vygotsky's social constructivist theory of mind, second language acquisition and learning motivation. He stressed further said that these theories explain the theoretical and conceptual foundations of collaborative learning which

focuses not only on individual learners' cognitive development but on the overall development of learners as well.

Dillenbourg *et al*. (1996) however believed that much of the research on collaborative and cooperative learning are rooted in the work of Piaget and Vygotsky:

Piaget's system of developmental stages described children's cognitive progress as well as ideas related to cognitive conflict. This refers to the sense of dissonance experienced when one becomes aware of a discrepancy between one's existing cognitive framework and new information or experiences.

Vygotsky's work placed more emphasis on the value of social interaction itself for causing individual cognitive change, as opposed to being merely stimulated by it (Dillenbourg *et al*., 1996). In this formulation, social interaction is internalized, which causes conceptual changes as participants appreciate new understandings. (Lai, 2011). Dillenbourg (1999) further stressed that the concept of collaborative learning is largely rooted in Vygotsky's sociocultural theory (SCT) which views learning as inherently a social process activated through the Zone of Proximal Development (ZPD).

2.3   Characteristics of Collaborative and Traditional Learning

In collaborative learning, educators are encouraged to develop explicit instruction for collaboration skills which will encourage the students to actively participate in the group work (Fall *et al*, 1997). Similarly, Webb (1991 and 1995) recommends training students in general interpersonal and teamwork skills, including coordination, communication, conflict resolution, decision making, problem solving, and negotiation.

Some of the characteristics of collaborative learning approach for students include:

- Rely on active student participation rather than passive lecture-based teaching
- Students assume a degree of responsibility for their own learning
- Teachers act as facilitators to learning
- Require pupils to complete a task/project
- Instil team building skills and encourage social interaction
- Help to prepare students for the world of work
- Enhance deeper cognitive skills
- Create shared learning experiences

- Increase levels of information retention
- Embrace student diversity (Clare, 2015)

Johnsons (1994) cited in Woods and Chen (2010) opined that for the collaborative learning approach effort to be more productive than competitive or individualistic methods, five conditions must be met:

1. Clearly perceived positive interdependence;
2. Considerable promotive interaction;
3. Clearly perceived individual accountability and personal responsibility to achieve the group's goals;
4. Frequent use of the relevant interpersonal and small-group skills, and;
5. Frequent and regular group processing of current functioning to improve the group's future effectiveness.

Table 2.1: Characteristics of collaborative learning and traditional language teaching mode

Characteristics	Collaborative	Traditional
Goal structure	Collaborative	Competitive or individualistic
Role of students	Active participation, autonomous learners	Passive recipients
Role of teacher	Role of teacher	Controller, knowledge transmitter, major source of assistance
Material used	Materials are arranged according to the purpose of learning	Completed set of materials assigned by university
Types of activities	Various types of activities to engage learners in a shared learning community	Knowledge recall and review; language drill practice
Types of interaction	Intense student–student interaction	Some talking among students, mainly teacher–student type
Classroom physical set-up	U-shaped or CL groups	Traditional rows of separate desks

Teacher-student relationship	Collaborative and equal	Superior–inferior, or equal
Independence	None or negative	Positive
Learning expectations	Group success as well as individual's	Evaluating one's own progress in learning

Adapted from Zhang (2010) in Lin (2015)

2.4 Benefits of collaborative learning

The Benefits of collaborative learning are numerous. Laal and Ghodsi (2012) summarizes them into four major categories of; social, psychological, academic and assessment:

Social benefits;

- It helps to develop a social support system for learners;
- It leads to build diversity understanding among students and staff;
- It establishes a positive atmosphere for modelling and practicing cooperation, and;
- It develops learning communities.

Psychological benefits;

- Student-centered instruction increases students' self-esteem;
- Cooperation reduces anxiety, and;
- Collaborative learning develops positive attitudes towards teachers.

Academic benefits;

- collaborative learning Promotes critical thinking skills
- Involves students actively in the learning process
- Classroom results are improved
- Models appropriate student problem solving techniques
- Large lectures can be personalized
- collaborative learning is especially helpful in motivating students in specific curriculum

Assessment benefits;

- Alternate student and teacher assessment techniques;
- Collaborative teaching techniques utilize a variety of assessments.

2.5 Assessment Challenges in Collaborative Learning

There are a lot of challenges in measuring students' collaboration skills in obtaining individual student scores.

Webb (1995) in Lie (2011) opined four potential purposes of group-based assessments:

1. Educators may be trying to measure individual student learning, as evidenced by student knowledge or skill, in the context of a group activity.
2. The goal may be to assess an individual student's ability to learn from collaboration, which is typically accomplished by including both individual and group assessment components.
3. The goal is to assess group productivity, as evidenced by the quality or quantity of a product completed collaboratively.
4. Educators may be trying to measure a student's collaboration skills, such as coordination, communication, decision-making, conflict resolution, and negotiation.

2.6 Suggestions on Designing Group Based Assessments

Assessments of students are determined by the objective(s) of the educators. Some of these objectives were suggested by Webb (1995) as highlighted below:

1. To measure individual student learning ability, group-based assessments should not be used at all. The best measure of individual student knowledge and skills is an individual student assessment.
2. To measure an individual's ability to learn from collaboration, assessments should be multi-staged, both individual and group assessments should be used.
3. To measure group productivity in students, educators should provide a task that can be completed and focus evaluation on the completed task rather than individual student contributions or student interactions.
4. To measure students' ability to collaborate, students should be encouraged to exchange ideas, opinions, and knowledge, and to help one another, work together, actively seek help, justify and explain ideas, and give elaborated explanations.

This information corresponds vividly to Vygotsky's idea of the zone of proximal development, since it tries to identify both what an individual can accomplish alone, and that which can be accomplished with the help of more competent peers (Lie, 2015).

2.7 How to Effectively Use Collaborative Learning Techniques

To use collaborative learning techniques effectively, the task can be designed and grouped into five sections according to Lie (2015):

a.   Structuring Collaborative Learning Tasks
–   Design tasks that engender collaboration and foster the kind of thinking important for learning.
–   What are your learning goals? (knowledge, skills, abilities, habits of mind, qualities of character)
–   Task prompts i.e. questions that induce the kind of thinking one expects
–   The type of interaction and discourse that should take place.

b.   Orienting and Training of Participating Students
–   Students should be trained on how to participate effectively in group learning situations.
–   What kind of thinking is expected of them.
–   Students should know how to interact in the ways expected of them.

c.   Forming Groups
–   The composition of groups can influence how they function.
–   Instructor assigns students to groups vs. students select group members vs. random assignment

d.   Facilitating Student Collaboration
–   What can/should instructors do to facilitate student collaboration?
–   Clarify collaborative expectations
–   Monitor group work in class or online

Introducing the activity
- Explain activity
- Clarify objectives
- Outline the procedures
- Give examples if needed
- Remind groups of ground rules for group interaction
- Set time limits
- Provide the prompt, task or problem
- Field questions before starting
- Observing, monitoring, interacting

e.   Grading/Evaluating Students in Collaborative Learning Situations
How can/should you grade students in collaborative learning situations?
How can grading promote or impede collaboration?
– Whether to grade and what to grade.
       – Group grade vs. Individual accountability

3.   Methodology/Materials

The study was on the impact of collaborative educational approach on statistics and linear algebra learning involving undergraduate students of Federal college of Education Katsina, Katsina State of Nigeria. The objective is to investigate whether the performance in statistics and linear algebra of those students taught using collaborative educational approach is better than those taught using traditional method or not and Pre-test post-test experimental design was used for the experiment.

3.1   Research Hypothesis

The following hypotheses were formulated for the purpose of the research work:

H$_{o1}$:   There is no significant difference between the pre-test scores in linear algebra of students taught using collaborative educational approach and those taught using the traditional method.

H$_{o2}$:   There is no significant difference between the post-test scores in linear algebra of students taught using collaborative educational approach and those taught using the traditional method.

H$_{o3}$:   There is no significant difference between the pre-test scores in statistics of students taught using collaborative educational approach and those taught using the traditional method.

H$_{o4}$:   There is no significant difference between the post-test scores in statistics of students taught using collaborative educational approach and those taught using the traditional method.

H$_{o5}$:   There is no significant difference between the achievement scores in linear algebra and statistics of students both taught using collaborative educational approach.

Thirty students each were randomly selected for both the experimental and control groups. A pre –test was first administered to the two groups to ascertain their prior knowledge or levels of performance before administering the two methods. The control group were taught using the traditional method while the experimental group were taught using the collaborative educational approach. The Researcher Made Test (RMT) on statistics and linear algebra were used for the data collection.

This research work evaluated the students individually as well as in groups to measure each student's performance and their abilities collectively. This was supported by many authors who advocated for grading systems that combines students' individual evaluation with group performance (Cerbin (2010) and Lie (2011)). Therefore, individual's overall grade was 60% while the group grading was 40%

4. Results and Findings

After the experiments, the results were analysed using SPSS and tabulated as given in the table below.

		N	MEAN	SD	t	df	Sig. (2-tailed)
Pair 1	PRETRADLA PRECOLLA	35.07 34.37	30 30	8.115 8.838	.462	29	.648
Pair 2	POSTTRADLA POSTCOLLA	47.97 58.00	30 30	9.212 8.642	-4.240	29	.000
Pair 3	PRETRADST PRECOLABST	33.63 34.00	30 30	7.194 5.558	-.339	29	.737
Pair 4	POSTTRADST POSTCOLABST	48.87 60.10	30 30	6.219 9.820	-5.797	29	.000
Pair 5	POSTCOLLA POSTCOLABST	58.00 60.10	30 30	8.642 9.820	-.759	29	.454

Table 4.1: The t– test Analysis of Pre-test and Post-test Data for the Traditional and Collaborative Learning Groups.

(See appendix 1 for detailed computer analysis)

From table 4.1 above, the pair 1 which compares the prior knowledge or post-test of traditional with collaborative method in linear algebra shows that there is no significant difference between their performances since the p-value of 0.648 is greater than 0.05.

After administering the learning techniques i.e. post-test, it was discovered that the p = 0.000 < 0.05. This shows that there was significant difference between the mean scores of those taught with the traditional method and those taught using collaborative learning techniques. The means of 47.97 and 58.00 for traditional and collaborative techniques shows a difference of 10.03 which is remarkable improvement.

The pre-test for statistics group gave a p-value of 0.737 which was greater than p = 0.05. Therefore, the null hypothesis was rejected given a conclusion that there was no significant difference between the performances of the control and the experimental groups on which statistics were taught before the experiment.

Consequently, after the experiment in which the control group were taught using the traditional method and the experimental group taught using the collaborative learning techniques, the p-value of 0.000 < p = 0.05. This shows a significant difference in their performances and the mean difference was 11.23.

The results for post-tests of both collaborative learning techniques in linear algebra was compared with that of statistics and the p = 0.454 > p = 0.05. This shows that there is no significant difference in their performances which may be as a result of the application of the same techniques in the teaching and learning processes. Here, the contribution to teaching and learning processes is the experimentation of collaborative learning techniques to achieve a better performance and attain the objectives of any lesson.

5. Conclusion

In conclusion, the findings revealed that:

1. The students' level of performance before the experiment i.e. pre – test in linear algebra and statistics were very low for both the control and experimental groups.
2. Collaborative learning techniques can effectively improve and enhance the level of understanding of linear algebra and statistics as well as achieving the stated objectives of the lesson in undergraduate mathematics courses more than the traditional method.

5.1 Recommendations

In view of the fact that the students exposed to collaborative learning techniques had better improvement and achievement than those students taught using the traditional method in linear algebra and statistics, the following are thereby recommended:

1. Teachers should further be sensitised on the use of collaborative learning techniques in linear algebra and statistics by way of more workshops and seminars.
2. No matter the qualification of teaching staff, they should possess teaching qualifications and if possible should register with one of the teachers' registration council. **This point is very important since driver will never be allowed to drive except with a driving licence which must have been given to them after satisfied fit to drive.**
3. As professional teachers, the objectives of the lesson should be properly and clearly stated at the beginning of each lesson and adequately evaluated at the end of the lesson.

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APPENDIX 1

```
GET
 FILE='C:\Users\TAJUDEEN A\Documents\COLLABORATIVE
LEARNING IN STA AND LINEAR ALGEBRA.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
GET
 FILE='C:\Users\TAJUDEEN A\Documents\COLLABORATION
AND TRADITIONAL TEACHING METHODS COMPAIRED.sav'.
DATASET NAME DataSet2 WINDOW=FRONT.
DATASET ACTIVATE DataSet1.
DATASET ACTIVATE DataSet1.


SAVE OUTFILE='C:\Users\TAJUDEEN
A\Documents\COLLABORATIVE LEARNING IN STA AND
LINEAR ALGEBRA.sav'
 /COMPRESSED.
T-TEST PAIRS=PRETRADLA POSTTRADLA PRETRADST
POSTTRADST POSTCOLLA WITH PRECOLLA POSTCOLLA
PRECOLABST
  POSTCOLABST POSTCOLABST (PAIRED)
 /CRITERIA=CI(.9500)
 /MISSING=ANALYSIS.
```

T-Test

[DataSet1] C:\Users\TAJUDEEN
A\Documents\COLLABORATIVE LEARNING IN STA AND
LINEAR ALGEBRA.sav

Paired Samples Statistics

		Mean	N	Std. Dev.	Std. Error Mean
Pair 1	PRETRADLA	35.07	30	8.115	1.482
	PRECOLLA	34.37	30	8.838	1.614
Pair 2	POSTTRADLA	47.97	30	9.212	1.682
	POSTCOLLA	58.00	30	8.642	1.578
Pair 3	PRETRADST	33.63	30	7.194	1.313
	PRECOLABST	34.00	30	5.558	1.015
Pair 4	POSTTRADST	48.87	30	6.219	1.135
	POSTCOLABST	60.10	30	9.820	1.793
Pair 5	POSTCOLLA	58.00	30	8.642	1.578
	POSTCOLABST	60.10	30	9.820	1.793

Paired Samples Correlations

		N	Corr.	Sig.
Pair 1	PRETRADLA & PRECOLLA	30	.523	.003
Pair 2	POSTTRADLA & POSTCOLLA	30	-.053	.782
Pair 3	PRETRADST & PRECOLABST	30	.594	.001
Pair 4	POSTTRADST & POSTCOLABST	30	.184	.331
Pair 5	POSTCOLLA & POSTCOLABST	30	-.345	.062

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
	.700	8.301	1.516	-2.400	3.800	.462	29	.648
	-10.03	12.960	2.366	-14.873	-5.194	-4.240	29	.000
	-.367	5.928	1.082	-2.580	1.847	-.339	29	.737
	-11.23	10.615	1.938	-15.197	-7.270	-5.797	29	.000
	-2.100	15.155	2.767	-7.759	3.559	-.759	29	.454

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